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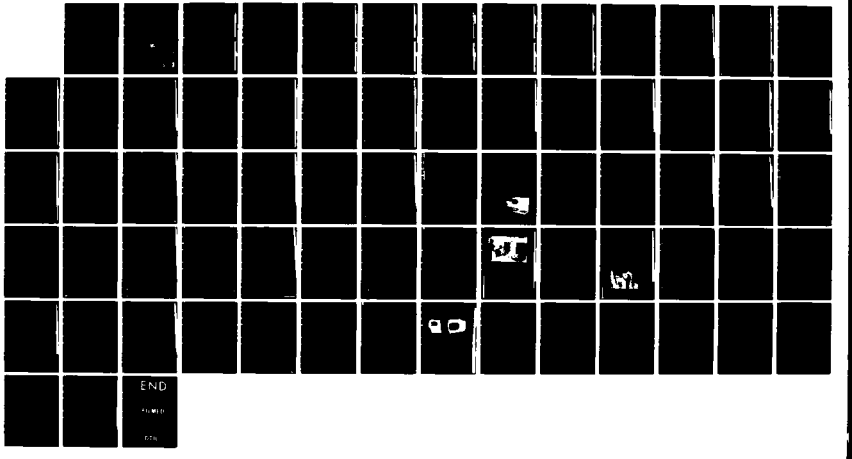

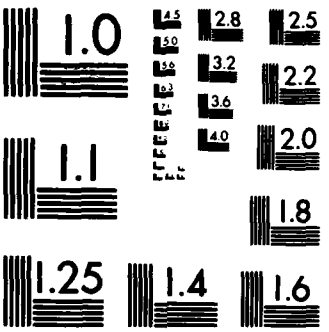

OPNAVNOTE 3905

THE 7th ANNUAL REPORT

ON

THE UTILIZATION OF NAVY PEOPLE-RELATED RDT&E

FISCAL YEAR 1983

Contract N66001-83-C-0358

ASSEMBLED BY:

NAVY PERSONNEL RESEARCH AND DEVELOPMENT CENTER
SAN DIEGO, CALIFORNIA 92152

JUNE 1984

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DEPARTMENT OF THE NAVY
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WASHINGTON, DC 20350

IN REPLY REFER TO
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OPNAV NOTICE 3905

From: Chief of Naval Operations

Subj: SEVENTH ANNUAL REPORT ON THE UTILIZATION OF PEOPLE-RELATED RESEARCH, DEVELOPMENT, TEST, AND EVALUATION (RDT&E)

Ref: (a) UNDSECNAV Memo of 26 Sept 1978, Subj: Navy Manpower, Personnel and Training Research, Development and Studies (NOTAL)
(b) General Accounting Office Report FPCD 77-43 of 22 Apr 1977 (NOTAL)

Encl: (1) Seventh Annual Report on the Utilization of People-Related Navy RDT&E

1. Purpose. To issue the Seventh Annual Report on the Utilization of People-Related Navy RDT&E (enclosure (1)) and forward it for information and appropriate action. This report contains examples of the use of this R&D. It is a principal means whereby the Navy complies with the recommendations of references (a) and (b) that utilization be encouraged, that communication between the user and researcher be improved, and that utilization of this R&D be tracked.

2. Action

a. Addressees are requested to review enclosure (1) to identify any of the following:

(1) RDT&E that they have used but that has not been reported in enclosure (1) or any of its predecessors.

(2) Completed RDT&E that might be useful in activities under their cognizance.

(3) RDT&E near completion that they should monitor to use when completed.

b. Any previously unreported instances of utilization should be reported to:

Commanding Officer
Navy Personnel Research and Development Center
Code 303
San Diego, CA 92125-6800

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c. Addressees desiring assistance in using completed RDT&E or in monitoring potentially useful R&D should direct inquiries to the appropriate R&D organizations as listed in enclosure (1).

d. Request appropriate action be completed by 31 May 1985. Negative reports are not required.

3. Report. Symbol OPNAV 3905-1 has been assigned to the requirement contained in paragraph 2. This information will be requested yearly by notice.

J. T. PARKER
Rear Admiral, U. S. Navy
Deputy Director
Research, Development, Test and Evaluation

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OPNAVNOTE 3905

THE 7th ANNUAL REPORT

ON

THE UTILIZATION OF NAVY PEOPLE-RELATED RDT&E

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Enclosure (1)

FOREWORD

People-related research, development, test and evaluation (RDT&E) is of great significance to the Navy. Over one-half of the Navy's budget is spent on people-related costs. However, the benefits of the people-related RDT&E program are much less visible than those of hardware or weapon systems programs. Therefore, a continuous effort must be made to increase the awareness of both users and DoD/government policy makers of the important progress being made in the area of people-related RDT&E. This seventh edition of the annual report on Navy people-related RDT&E represents the continuation of the effort to publicize the accomplishments of this program.

Those who provide financial and other support for this RDT&E also are interested in improving the transfer of the technology into the hands of all users who have potential applications. Thus, this report is intended to increase the utilization of newly developed training and personnel systems technology, and also to foster greater Navy-wide and interservice coordination of efforts in people-related RDT&E.

In each project summary, emphasis is placed on the operational need that generated the effort, the approach taken and results, the manner in which the research products or results were (or will be) utilized, and the actual or potential "payoff." Each summary also includes a section which identifies the performing activity, sources of funding for the project, and sources of additional information. A diagram is provided illustrating the evolution of the effort through research, development, and implementation. In this edition, an important addition is the incorporation within most summaries of the appropriate Manpower and Training Research Information System (MATRIS) language from which additional information may be acquired.

To enhance the continuity of information flow, the seventh edition includes an index in which the reports are arranged according to the MATRIS Human Resources Research Indexing vocabulary.

This report was compiled by the Navy Personnel Research and Development Center, San Diego, California. The manuscript was prepared by Resource Consultants, Inc. of McLean, Virginia under Contract N66001-83-C-0358. Appreciation is expressed to participating personnel at each contributing command, and also to those individuals who contributed documentation, clarification, and sound advice while the report was in preparation. Inquiries and comments from sponsoring and user commands are encouraged.

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INTRODUCTION

The Setting

In his statement of 13 March 1984 to the House Armed Services Committee, Vice Admiral Lawrence, USN, Deputy Chief of Naval Operations (Manpower, Personnel and Training) (OP-01) and Chief of Naval Personnel, provided a reassuring view of the Navy's personnel posture. Among his comments were:

> Significant positive changes are occurring in the personnel structure of the Navy. The experience level of our personnel is increasing. The portion of the enlisted force with over four years of service increased by 8.3% between December 1980 and the end of FY 1983. Recruits scoring above average on the Armed Forces Qualifying Test rose from 64.5% in 1981 to 70.1% in 1983. New enlistees with high school diplomas increased from 75.8% to 91.1% in the same timeframe. The shortage of petty officers has declined from 22,212 in 1981 to 9,286 in FY 1983. The shortage of mid-grade pilots decreased from 2,350 in 1981 to 1,087 in 1983.
>
> The dramatic turnaround in the number and quality of the people who man our Navy today, compared to the late 1970s, can be attributed to our improved position in the manpower market and an intensive retention effort. Increased compensation levels in the early 1980s, renewed patriotism which enhanced the attractiveness of a military career, and the high civilian unemployment rate all contributed to the change.
>
> The challenge we face now is to meet increasing manpower requirements with personnel possessing high training potential while, at the same time, civilian employment opportunities are increasing and the pool of 18-21 year old men is decreasing. We know from our experience in the 1970s that in order to meet our manpower requirements given these conditions military pay must be restored to levels comparable to what is offered by other employers and that the total compensation package must be competitive with that available in the private sector. Additionally, recruiting and retention efforts must be intensified.
>
> To meet our manpower requirements we must examine and implement a wide range of management initiatives. One such initiative is the identification of active force missions which can be transferred to the Naval Reserves without degrading our ability to support a forward deployed maritime strategy and respond to today's operational requirements. Additionally, we are working to eliminate manning imbalances in the more senior paygrades of many enlisted communities. Within legal constraints regarding employment of women we are working to take full advantage of their capabilities. Increased use of Federal civilian employees and private contractors is also being carefully considered as we work to accomplish our mission in the most efficient way possible.
>
> Management initiatives alone cannot totally eliminate the need for greater end strength to adequately man an expanding fleet, raise combat readiness levels, and meet heavy operational commitments.
>
> In order to build a Navy capable of fulfilling our maritime strategy it is essential to increase overall personnel strength during the next five years.

In the same statement, however, it is clear that Vice Admiral Lawrence is well aware of the need for continuing improvements through research and development. He makes this statement, which was also made to the Senate Armed Services Committee on 9 March 1984:

> In addition to manpower management systems already in place, Navy is conducting research and development in new manpower, personnel, and training systems. The FY 1985 budget contains funds for R&D in the areas of human factors engineering, manpower control systems, education and training, training device technology, and training and personnel systems development. I urge your full support for this modest program which is essential to our efforts to further increase personnel management and training efficiency.

The Training and Personnel Systems Technology Program

Research and development is the enterprise in which we engage as a means to improve the use of our resources in meeting future needs. In the case of the men and women, civilian, military and Reserve, who people the Navy, the research and development program within the Department of Defense is titled the "Training and Personnel Systems Technology (TPST) Program." The totality of the TPST Program in all the services approximates slightly more than 1 percent of the Defense research and development program.

The TPST Program develops and initiates implementation of new techniques in four categories related to the effective use of our human resources. These four categories, which form the organizational structure of this report, are:

- Manpower and Personnel
- Education and Training
- Human Factors Engineering
- Simulation and Training Devices.

With changes in the policy and economic environments, in the structure of the operational forces, and in the demographic and sociological makeup of the nation as a whole, particular areas of effort at times assume greater relative importance. The emphases in TPST during the period covered by this report have been on efforts to:

- Maintain performance levels
- Predict the effectiveness of personnel

- Develop lower cost training that is more effective and more available
- Build the technology base to meet future needs
- Make greater use of available microprocessor technology
- Enhance the impact of manpower, personnel and training in the weapon systems acquisition cycle.

Manpower and Training Research Information System (MATRIS)

This edition of the annual report introduces a new feature to encourage communication among researchers and managers and to foster improved utilization of Navy research and development. This feature is the addition, at the end of most summaries, of indexing terms assigned by the MATRIS Office, a field office of the Defense Technical Information Center (DTIC). These indexing terms, similar to keywords, are listed in a specialized MATRIS vocabulary that was constructed for use in the TPST area of interest. These indexing terms can be referred to when requesting retrievals from the MATRIS Office.

The MATRIS data base contains work unit, project, and program element level information on current and recently completed people-related research in the TPST area of the Department of Defense. Registered DTIC users—researchers, managers, and planners—can obtain a variety of retrievals to identify related research, to uncover research gaps, and to provide an overall picture of current Department of Defense people-related research and development.

For further information, contact:

Defense Technical Information Center
MATRIS Office, San Diego
DTIC-R
San Diego, CA 92152
(619) 225-2056 Autovon 933-2056

Emphases in This Report

The Utilization Report for FY83 focuses on work which has been completed recently and which emphasized improvements such as:

- Exploring new ground in ASW simulation technology for training.
- Researching and developing innovative uses of microcomputer technology for training applications.
- Assessing the feasibility of directly recruiting graduates of vocational/technical colleges as petty officers to augment the quality and quantity of skilled manpower.
- Developing a program that integrates technical progress, shipboard adjustments, and educational opportunities into an individualized career path.
- Investigating differences in performance evaluations of male and female URL officers to facilitate gender-free promotion decisions.
- Addressing training inefficiencies present in the Marine Corps professional military education system.
- Developing and testing methods for reducing the skill levels required in the operation of ship propulsion systems.
- Providing specific human factors input early in the sonar system design process.
- Resolving the problem of excessive visual/manual workload in naval air systems with the development of vocal/auditory input and output modes.
- Enhancing capabilities regarding the man/machine interface between shipboard damage control consoles and operators to aid ships' personnel in efficiently coping with casualties.
- Applying technologies such as robotics and automation to specific Navy requirements, to improve productivity and better utilize personnel.
- Developing an adequate quantitative method to relate personnel resources to readiness.
- Developing a computerized adaptive screening test to make more efficient and effective identification and enlistment of military eligibles.
- Formulating comprehensive retention planning and forecasting models.
- Improving the techniques available for distributing recruiting resources to take better advantage of the market.
- Providing a better relationship between the distribution of officer personnel in specific skill areas and their career development.
- Predicting officer losses in sufficient time to improve manpower planning capabilities.
- Developing data which can be used to design support programs for Navy families.
- Continuing the development of a better system for maintaining the service records of Navy personnel.
- Creating better procedures for designing the interface between the human and the computer in information sharing systems.
- Developing improved techniques for testing sonar signal processing systems.
- Facilitating the utilization of new infrared sensors.
- Controlling smoke and toxic gases in the shipboard environment.
- Reducing accidents due to stationkeeping errors during replenishment operations underway.
- Aiding the capability of technicians to troubleshoot complex equipment.

MANPOWER AND PERSONNEL

In the Department of Defense, Manpower and Personnel RDT&E involves "Development of techniques/methods for utilizing available personnel resources through improved selection, job assignment, organization analysis and management techniques to meet combat-available and projected force needs."

The Navy must continually improve its manpower and personnel processes. These processes include: estimating life-cycle manpower requirements, developing more effective procedures for acquiring and classifying personnel, increasing productivity, and maintaining management capability to respond and adapt effectively to a changing force structure. A major focus at the present time is on finding ways to increase productivity and optimize the use of personnel resources while reducing or restraining costs.

Projects reported this year are:

- **Relating Resources to Readiness: Personnel Attributes, Fill Ratios, and CASREPs**
- **Predicting the Impact of Advertising and Recruiters on Military Accessions**
- **Computerized Adaptive Screening Test (CAST)**
- **Personnel Distribution and Career Development**
- **Gender Differences in Performance Evaluation**
- **Retention Planning Models**
- **Forecasting Officer Loss Behavior**
- **Department of the Navy Family Advocacy Program**
- ***Microfiche Title Generation System***

RELATING RESOURCES TO READINESS: PERSONNEL ATTRIBUTES, FILL RATIOS, AND CASREPs

Need

Given constraints on end-strengths, the frequent use of pay bonuses to retain sailors in certain jobs, and the ever-increasing costs of training, recruitment, and payroll, the Navy is trying to develop an adequate quantitative method to describe relationships between personnel resources and ship readiness. With an explicit, quantitative method for determining the "best" manning for certain critical ratings with the "correct" number of sailors having the "proper" attributes, the Navy could most cost-effectively enhance the individual and collective readiness of its ships.

At the request of the Office of the Deputy Chief of Naval Operations (Manpower, Personnel and Training) (OP-01), and the Program Resource Appraisal Division (OP-91), and in cooperation with the staffs and resources of the Defense Manpower Data Center (DMDC) and the U.S. Navy Ships Parts Control Center (SPCC), selected personnel and maintenance records were assembled to examine in greater detail the concept and its development.

Approach and Results

The desired method was developed by assessing relationships between *fill ratios* (the number of personnel aboard versus personnel required by the Ship *Manpower* Document), personnel attributes (e.g., years of education, Armed Forces Qualifying Test percentile, entry age, present age, paygrade, years of active duty, time in grade, and "turbulence" or turnover), and the readiness of vessels in three ship classes (DD 963s, DDG 2s, and CGs). Readiness was measured by criteria either extracted or derived from the SPCC summary Casualty Reports (CASREPs), including such things as total downtime, maintenance downtime, and two severity-based, weighted "readiness" indices. Personnel attributes were aggregated over the members of a given rating aboard a given ship within a given quarter. Twenty-seven quarters of such personnel data were then merged with the aggregated maintenance/repair records for that ship (or those systems aboard that ship for which responsibility could be assigned to that rating) in that quarter. A ship-quarter was the unit of analysis.

Several regression models relating the fill ratios and personnel attributes to the CASREP data were computed, and their statistically significant coefficients were subjected to interpretation. The results provide a complicated picture for the twelve selected job ratings, but certain general findings do emerge:

- Differences between ships' performances, regardless of the personnel assigned to them, are often quite pronounced; i.e., there are "good" ships and "bad" ships, despite the quality of personnel assigned to them.
- Higher fill ratios did not always contribute to improvements in readiness; in fact, higher fill ratios for some ratings actually were associated with degradations in readiness.
- Having crews a greater percentage of which are high-school graduates, and who have more experience, is generally associated with enhanced readiness.
- A great many findings were counter-intuitive; e.g., a higher percentage of turnover within certain ratings actually seems to enhance readiness.

Utilization and Impact

Certain results from this work were utilized in a Chief of Naval Operations Program Analysis Memorandum (CPAM) for 1986, in December 1983, to justify the acquisition of additional personnel, or for targeting incentives to selected ratings to improve their retention. Follow-on effort will continue to explore the data bases developed in the present effort by screening the selected criteria, more carefully examining time-series models, specifying additional potentially important model components, and examining the effects of aggregation bias.

Research and Development Notes

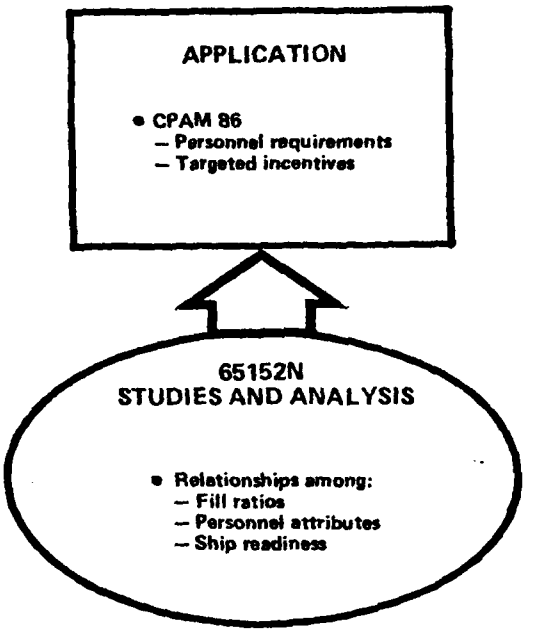
This project was conducted at the Department of Administrative Sciences, Naval Postgraduate School, Monterey, California, 93943. It is identified as An Assessment of Personnel Attributes and Ships' Readiness Relationships: Research Project No. R0132. The responsible researcher was Dr. William E. McGarvey (Code 54Ms), Department of Administrative Sciences, Naval Postgraduate School, Monterey, California, 93943, (408) 646-2643. Funding was provided by OP-91, in Program Element 65152N, Studies and Analysis Support-Navy. The project started on 18 August 1983, and funding expired on 31 December 1983. BDM Services Corporation as well as DMDC provided useful consultation, support, and coordination. LCDR John D. May's master's thesis, *An Analysis of the Relationships of Personnel Characteristics to the Performance of DD 963 Class Ships*, Naval Postgraduate School, December, 1983, describes the preliminary stages of this work. A more complete technical report is forthcoming.

Additional information can be obtained from MATRIS using the following indexing vocuabulary:

- Primary Terms:
  - 8.05.04 Manning Effectivess
  - 5.02.05 Readiness (System/Unit, Personnel)
  - 8.07.03 Staffing Policies/Practices Evaluation
  - 8.01.24 Manpower Requirements Determination
- Secondary Terms:
  - 8.03.08 Skill Classes (Substitution, Shortages)
  - 8.02.13 Turnover

8.02.17	Manning Reduction (Essential Manning)
8.02.04	Job Specialty/Skill Imbalance (Prediction, Management)
8.01.28	Casualty Prediction/Estimation
10.08.06	Manning Determination

Program dynamics are:



PREDICTING THE IMPACT OF ADVERTISING AND RECRUITERS ON MILITARY ACCESSIONS

Need

Estimating the future supply and geographic distribution of military-available high school graduates with above-average Armed Services Vocational Aptitude Battery (ASVAB) test scores plays a critical role in a number of important decisions. One important decision requiring the best possible estimates concerns the geographical distribution and allocation of advertising funds and recruiters. Another decision concerns assigning realistic goals to different recruiting regions under given budget constraints. Decisions such as these are influenced by a large number of factors, including unemployment rate, seasonality, and demographics. Ideally, the Navy needs an empirically based model which allows the Navy Recruiting Command (NAVCRUITCOM) to state values for the relevant factors and to obtain an accurate prediction of the number of above-average enlistment contracts to be expected under the input conditions. The development of such a capability has become a matter of priority in view of scarce recruiting resources, mounting manpower requirements, and the declining manpower pool.

Approach and Results

This effort used a large existing, and constantly expanding, data base concerning both Navy recruiter contacts with potential enlistees and actual contracts signed. Analysis was designed to determine the relative importance of each of the variables which impact the number of contracts obtained.

One major result has been the construction and validation of a predictive model, more comprehensive and accurate than has previously been available, for use in allocating NAVCRUITCOM resources, setting goals over various recruiting districts and areas, and projecting future NAVCRUITCOM budgets.

Utilization and Impact

The capability which has been developed enables each Service to interpret and manage the effects of Joint and Service-specific advertising advantageously within a given geographic area, using its own data as well as data the Joint Services Advertising Program requires each Service to collect. Each Service can use the methodology to determine more accurately the requirement for advertising and recruiters together in an area, and to manage these resources. In taking such actions, the Service can consider the number and quality of enlistments required within the context of the area's economics, demographics, and the size and quality of its Delayed Entry Program.

The Navy intends to use this technology to:

- Validate predictors of above-average, high school graduate enlistment contracts.
- Increase detail in the current "market share model" by

incorporating analyses of the market by quality segments.

- Allocate advertising and distribute recruiters in a manner more sensitive to the market.
- Improve the precision of recruiting budgets.
- Relate allocation and distribution of Navy recruiting resources more productively in relation to Joint Service advertising.

Research and Development Notes

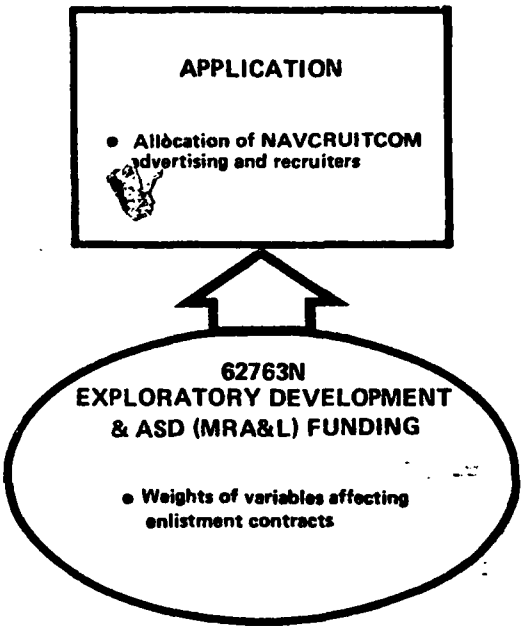
This work was funded by the Office of Naval Research (ONR) in Exploratory (6.2) Development Program Element 62763N, Personnel and Training Technology, Project RF63521, Manpower and Personnel Technology. Additional funding was provided by the Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics). The Scientific Officer was Dr. Bert T. King, ONR (Code 4420E), Arlington, Virginia, 22217, (202) 696-4503. The principal investigator was Dr. R. C. Morey, Duke University, Durham, North Carolina. Among the ten Technical Reports (TRs) are:

- Morey, R. C., *Comparison of the Marginal Cost-Effectiveness of Various Recruiting Resources for High School Graduate Enlistments,* (TR 200-7), Durham, NC: November 1982.
- Morey, R. C., *Leads and Quality Enlistments,* (TR 200-9), Durham, NC: February 1983.
- Morey, R. C., *Estimating Differences in Area-Level Impacts of Various Recruiting Resources,* (TR 200-10), Durham, NC: August 1983.

Additional information can be obtained from MATRIS using the following indexing vocabulary:

- Primary Terms:
  - 1.03.05 Recruiting Strategies/Practices/Procedures
  - 8.09.01 Recruiting Information System
  - 1.03.09 Market Analysis (Size/Characteristics)
  - 2.02.07 Demographic Criteria
- Secondary Terms:
  - 8.01.03 Manpower Planning Models, Military
  - 8.01.13 Enlistment Forecasting (Geographic Region)
  - 8.02.18 Enlistment Rates (Geographic Region)
  - 8.01.08 Enlistment Prediction Models
  - 1.03.12 Recruiting Costs
  - 1.03.01 Promotional Methods
  - 1.03.02 Advertising Media/Programs
  - 1.03.07 Recruiting, Success Factors

Program dynamics are:



COMPUTERIZED ADAPTIVE SCREENING TEST (CAST)

Need

Armed services recruiting faces serious challenges in the future due to the shrinking pool of military eligibles and potentially increased personnel expenditures. The result will be mostly competition for available personnel among colleges, industry and the several armed services, a competition that will increase the difficulty of recruiting. The best available candidates for enlistment must be located, enlisted, and optimally assigned. Neither fiscal nor personnel resources can be wasted. Finally, there must be a reduction in the nonessential tasks of the recruiter which detract from the primary mission of interacting with prospects and "selling [illegible]."

The Armed Services Vocational Aptitude Battery (ASVAB) constitutes a major element in the personnel selection and classification process for the military services. A weighted composite based upon four of the ten ASVAB tests constitutes the Armed Forces Qualification Test (AFQT) score. Applicants must achieve a minimum AFQT score to be eligible for enlistment. The ASVAB is administered to applicants at test sites that may be some distance from the recruiting station. Transportation from a recruiting station to a test site entails costs for the transportation and, in some cases, for meals and lodging. Costs are also incurred for personnel time at both the recruiting station and the test site. Currently, to avoid unnecessary costs, the Enlistment Screening Test (EST) is used at recruiting stations to predict

applicant AFQT scores. The EST is composed of 3 subtests totalling 48 items, with a total time of 45 minutes. This paper and pencil instrument was developed by the Air Force Human Resources Laboratory in 1976 and revised in 1981.

It has long been recognized that conventionally administered paper-and-pencil tests have a number of important shortcomings: excessive administration time; poor discrimination between individuals at both extremes of ability; limited capability for measuring some types of abilities (e.g., target identification and tracking); cumbersome and error-prone scoring; expensive and time-consuming replacement; and high vulnerability to theft and compromise. Computerized Adaptive Testing (CAT) offers substantial improvements in each of these areas.

Approach and Results

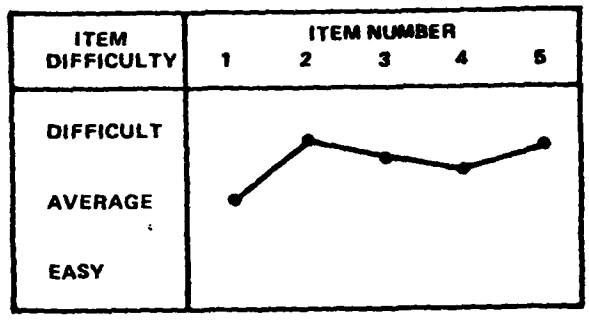
The development of the Computerized Adaptive Screening Test (CAST) represents the merging of three elements: research on a CAT instrument to replace the EST; item banks developed under a separate research effort; and the Army's implementation of the Joint Optical Information Network (JOIN) System, which will place microcomputers in Army recruiting stations.

Item response theory is the psychometric underpinning of this new screening instrument and for the growing field of computerized adaptive testing. As the name suggests, a computerized adaptive test is administered by computer. What is less obvious, however, is the way the test dynamically adapts itself to the examinee. As shown in the accompanying figure depicting item utilization, each examinee takes all the items in a conventional test, regardless of the match or mismatch between examinee ability level and item difficulty level. This is very inefficient, as easy items are

UTILIZATION OF TEST ITEMS

TYPE TEST	EXAMINEE'S ABILITY LEVEL	ITEM DIFFICULTY: EASY — DIFFICULT	TEST LENGTH
CONVENTIONAL	ALL		20
ADAPTIVE	LOW		10
	AVERAGE		10
	HIGH		10

wasted on high-ability examinees, and hard items are wasted on low-ability examinees. An adaptive test, on the other hand, adapts to the examinee as information on his or her ability level is collected during the testing process. This adaptive process is illustrated in the accompanying figure portraying adaptive test administration. Initially, since there is



ADAPTIVE TEST ADMINISTRATION

no information on the examinee, average ability is assumed, and an item of average difficulty is presented. After the examinee responds to the item, the ability estimate is updated. Then the next item to be administered is chosen, based upon the updated ability estimate. The process of choosing items, administering and scoring them, and updating the ability estimate continues until some stopping rule is satisfied (e.g., administration of a fixed number of items, or reduction of the standard error of estimate to a specified level).

Objectives of the CAST research and development were to design and develop a CAT instrument that could: operate on a stand-alone microcomputer system in recruiting stations as part of the JOIN system; reduce recruiters' administrative burden; and predict Army applicants' AFQT scores at least as accurately as the EST. CAST was envisioned as incorporating three subtests that would correspond to three of the four ASVAB tests used to calculate the AFQT composite score: Word Knowledge (WK), Arithmetic Reasoning (AR), and Paragraph Comprehension (PC).

Item banks for the CAST subtests were developed and calibrated under a contract with the University of Minnesota for use in CAT ASVAB research, and were made available for the present research effort. These item banks included 78 WK items, 247 AR items, and 25 PC items, together with the estimates of 3 parameters (discrimination, difficulty, and guessing) for each item. Also, an ability estimation procedure was chosen for scoring and determining the item selection sequence. The stopping rule chosen was the administration of a fixed number of items.

A pilot test of the three subtests using Marine Corps recruits indicated that the PC subtest added no incremental validity for predicting AFQT to that of an optimally weighted combination of WK and AR. This finding, in conjunction with the fact that the PC items are extremely time-consuming to administer, prompted elimination of PC from CAST.

Subsequent to the Marine recruit testing, a field test was undertaken to evaluate the validity of CAST with an applicant population. The CAST was administered to 312 Army applicants at the Los Angeles Military Entrance Processing Station (MEPS) between 29 November 1982 and 7 January 1983. CAST computer programs were written to provide interactive, user-friendly software that presumed no previous computer experience on the part of either the recruiter or the applicant. The instrument required an administration

time of approximately 20 minutes. The multiple correlation of the CAST subtests with AFQT was .85.

Utilization and Impact

CAST was made operational on all Army JOIN systems. Army enlisted applicants will directly interact with this system in the course of recruiting and accessioning. Since all services use EST, CAST is ready for adoption by other services as they bring automation to the recruiting arena.

CAST can be expected to improve the screening process and to dramatically reduce recruiters' administrative burdens while enhancing the image of the armed services and their recruiting personnel. CAST eliminates the need for traditional test materials, thereby saving storage space, replacement costs and recruiter time formerly used for test control and administration. Test security has also been improved.

Research and Development Notes

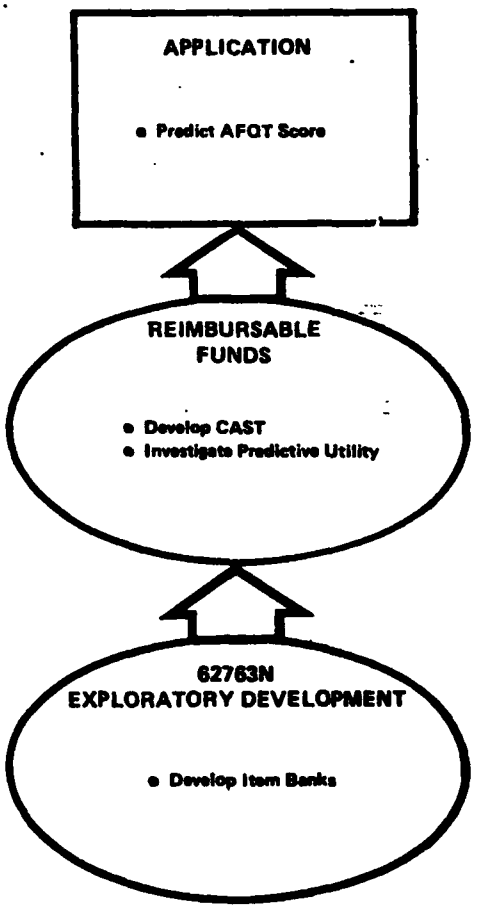
The Navy Personnel Research and Development Center (NAVPERSRANDCEN), through an agreement with the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI), conducted this research and development in support of the JOIN System being implemented nationwide by the U.S. Army Recruiting Command (USAREC). The principal investigator for NAVPERSRANDCEN was W. A. Sands. Publications describing this effort are listed below:

- Baker, H. G., Rafacz, B. A. & Sands, W. A., *Computerized Adaptive Screening Test (CAST): Development for Use in Military Recruiting Stations*, NAVPERSRANDCEN Technical Report (TR) 84-17. San Diego, CA: Navy Personnel Research and Development Center, January 1984.
- Sands, W. A. & Gade, P. A. An Application of Computerized Adaptive Testing in U.S. Army Recruiting, *Journal of Computer-Based Instruction*, Autumn 1983, Vol. 10, Nos. 3 & 4, pp. 87-89.
- Sands, W. A., Gade, P. A., & Bryan, J. D. Research and Development for the JOIN System, *Proceedings of the 24th Annual Conference of the Military Testing Association*, San Antonio, TX: Air Force Human Resources Laboratory and USAF Occupational Measurement Center, November 1982, pp. 599-604.
- Sands, W. A. & Rafacz, B. A., Field Test Evaluation of the Computerized Adaptive Screening Test (CAST), *Proceedings of the 25th Annual Conference of the Military Testing Association*, Pensacola, FL: Naval Education and Training Program Development Center, (In press).

Additional information can be obtained from MATRIS using the following vocabulary:

- Primary Terms:
  - 2.03.10 USAF Enlisted Screening Test (EST)
  - 2.04.02 Computer-Assisted Testing (CAT)
  - 2.04.01 Computer-Administered Ability Testing
  - 1.02.02 Recruiter Effectiveness
  - 5.03.24 Adaptive Testing
- Secondary Terms:
  - 5.09.14 Selection Test Development/Validation (SAB)
  - 5.09.18 Construction of Automated Tests
  - 5.12.21 Latent Trait Theory (Item Response Theory, ICC)
  - 5.09.15 Item Writing (Techniques)
  - 2.03.02 Armed Forces Qualification Test (AFQT)
  - 2.03.03 Armed Services Vocational Aptitude Battery (ASVAB)

Program dynamics are:



PERSONNEL DISTRIBUTION AND CAREER DEVELOPMENT

Need

The Navy is experiencing shortages in officers qualified to command major sea and shore activities. The shortage in qualified officers is also apparent in more junior grades and billets that require career personnel to have unique advanced technical abilities. A specific example of this is the shortage of technically qualified and experienced engineering department heads on surface ships. In this latter instance, the material readiness of the Fleet can be enhanced by having Chief Engineers who have had the requisite training and experience to manage their departments more effectively.

Approach and Results

From data which had been acquired on a much larger (9,000) group of Unrestricted Line Officers, questionnaire data were available to compare the career satisfaction and career intentions of Surface Warfare Officers who had specialized in engineering, weapons and combat systems, or operations, with the satisfaction and intentions of Surface Warfare Officers who had acquired experience in two or more departments. The latter could be considered generalists while the former three groups could be considered specialists. In addition to the questionnaire data from over 2,800 Surface Warfare Officers, more than 100 officers were interviewed and observations made while riding more than a dozen ships. The results indicated that the most junior Surface Warfare Officers (at grades of ensign and lieutenant junior grade) desired to specialize more in order to develop competency in their jobs. They indicated that they would be very satisfied with such specialized careers and would like to make the Navy a career if it became feasible to do so.

One of the career detractors that were identified was the requirement that junior officers assigned to the engineering department obtain their Engineering Officer of the Watch qualification prior to doing any work on their Surface Warfare Officer qualification. The Surface Warfare Officer qualification was required before the officers could be considered for selection to Department Head School. In contrast, the junior officers assigned to operations and weapons departments were not required to go through such specialized qualification training and could immediately start to work on their Surface Warfare Officer qualification. This gave the latter a decided advantage over the engineering specialists in achieving both their career requirements and selection for Department Head School.

In addition, the engineering specialists did not perceive themselves as having adequate experience in operations and weapons to do an effective job as a commanding officer even though they might be selected for such a position later in their careers. In essence, this group of specialists felt that they were changing careers from engineering specialist to management generalist (commanding officer) at the latter stage of their career (about 16 to 18 years) without sufficient training and experience to make the transition effectively.

Utilization and Impact

The results of the research were provided to the Surface Warfare Officer Panel. This group was involved in developing a proposed Surface Warfare Officer career strategy to improve the technical competence of engineering department heads and thereby enhance material readiness of the ships' propulsion plants. In addition to presentation of the research data, a Surface Warfare Officer career pattern was designed and proposed to the panel. The design included a means for engineering department heads to specialize as engineers, operations department personnel to specialize in tactics, and for weapons and combat systems department personnel to specialize in weapons system acquisition management. The career pattern proposed started the junior Surface Warfare Officers as specialists during the first ten years. After they had completed their department head tour, such officers were to be provided the opportunity to move from a specialist career path into the general management career path leading to executive officer and commanding officer. However, they could also stay as specialists and maintain a viable career.

Many of the recommendations and elements considered in the Surface Warfare Officer career pattern proposal were included in the new Surface Warfare Officer career pattern adopted by the Deputy Chief of Naval Operations (Surface Warfare) (OP-03) and the Fleet commands in 1983. Some incentives suggested by the research results were represented in the policies which were developed to make the new career pattern effective and acceptable to the members of that community.

The new career pattern is being promulgated throughout the Atlantic and Pacific Fleets. The Naval Postgraduate School is monitoring the effectiveness of the new career pattern. As this feedback is received during the implementation of the program over the ensuing four to five years, it may become necessary to establish a career path for an engineering specialist at the grades of lieutenant commander through captain. In addition, the results of this work may be used to modify the current career path so that individuals will specialize in operations or weapons and combat systems during the first ten years as well as engineering.

The research project will continue for four years. One of the future steps in the research is a repeated measurement of the 2,800 Surface Warfare Officers that participated in the 1982 data collection. The second data collection will provide a reference to determine the effectiveness of the current change in career patterns. It will also provide information which will support modifications in the Surface Warfare Officer career pattern.

The analyses have resulted in two new Advanced (6.3) Development programs to be initiated in FY86. One of the projects will investigate the qualifications for surface command and modify them so that they are more consistent in their application to the officers and more closely keyed to

the requirements of a commanding officer. The second project will improve the selection of officers for assignments such as Surface Department Head and Surface Command.

Research and Development Notes

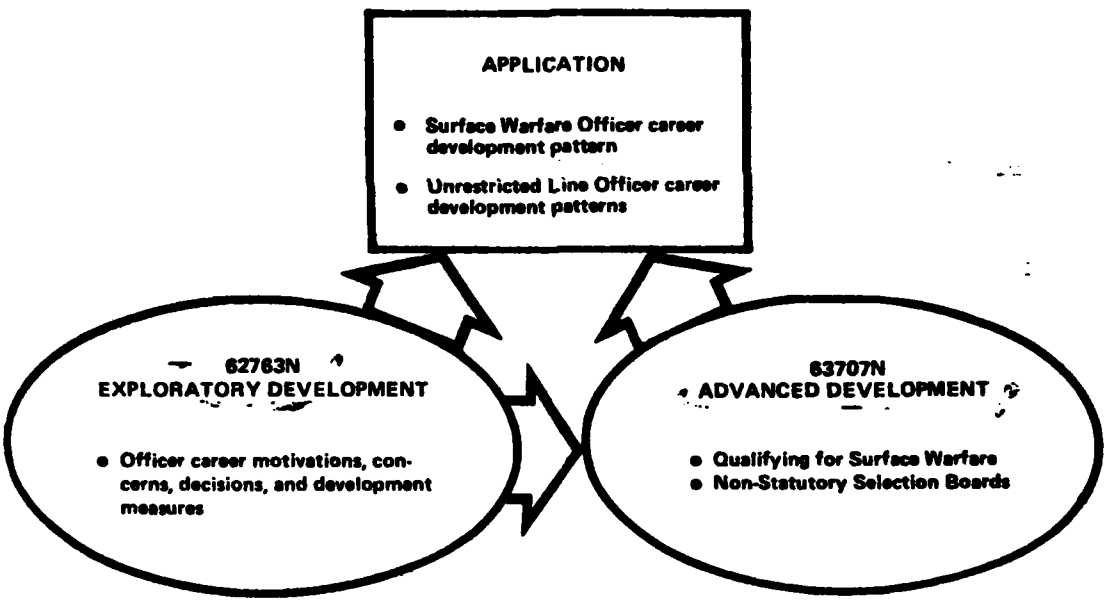
The Navy Personnel Research and Development Center (NAVPERSRANDCEN) initiated this research in FY81. It is sponsored by the Office of Naval Research (Code 270) in Program Element 62763N, Personnel and Training Technology. The principal investigator is Dr. Robert F. Morrison, NAVPERSRANDCEN (Code 442), (619) 225-6911. Relevant documents include:

- NAVPERSRANDCEN Technical Report (TR) 82-59, *Surface Warfare Junior Officer Retention: Early Career Development Factors*, August 1982.
- NAVPERSRANDCEN TR 83-6, *Surface Warfare Junior Officer Retention: Background and First Sea Tour Factors as Predictors of Continuance Beyond Obligated Service*, January 1983.
- NAVPERSRANDCEN Technical Note (TN) 83-11, *Officer Career Development: Surface Warfare Officer Interviews*, July 1983.

Additional information can be obtained from MATRIS using the following indexing vocabulary:

- Primary Terms:
  - 6.01.15 Career Path Definition
  - 6.01.12 Career Monitoring/Management (Officer)
  - 13.02.57 Surface Warfare Officer (SWO)
- Secondary Terms:
  - 6.01.07 Career Plan (Instructor)
  - 6.06.05 Technical Qualifications Analysis
  - 2.06.04 Assignment Strategies
  - 6.13.03 Personnel Policies
  - 6.04.13 Job Satisfaction/Reward
  - 6.04.36 Career Changes (Lateral Movement, Lateral Transfer)
  - 13.01.18 Officer Personnel
  - 13.02.45 Engineering Personnel (Shipboard)

Program dynamics are:



GENDER DIFFERENCES IN PERFORMANCE EVALUATION

Need

With the passage of the Defense Officer Personnel Management Act (DOPMA) in September 1981, separate selection boards for male and female naval officers were abolished. In recognition of the restrictions on women officers' assignments, selection boards convened since that date have been instructed to base their recommendations for promotion on performance factors and pay scant attention to career experiences. However, research in the civilian sector consistently finds that men and women are evaluated differently by supervisors, even when the work behavior being judged is described identically. Therefore, while the intent of guidance to selection boards cannot be faulted, the danger is that the evaluations being reviewed, i.e., the officer fitness reports, may not be gender free.

The Chief of Naval Operations, in expressing his goal of ensuring equity in the performance evaluation system, stated that "limited manpower within the Navy demands optimum use and progression of personnel. A sensitive assessment of personnel evaluations within the Navy is required to ensure that there are no deterrents to promotion due to race, ethnicity, or sex. . ." (OPNAVINST 5354.3 of 7 October 1981). As an early step toward meeting this goal, a review of fitness reports was conducted to determine whether or not differences exist in the evaluations of male and female unrestricted line (URL) officers.

Approach and Results

The sample was selected from a group of URL officers being considered for promotion to Lieutenant Commander in 1981. Every woman officer in the group was included in the research (N=120) along with every 30th male officer (N=119). The most recent regular (versus special) fitness report for each of these officers was the primary source of data.

Quantitative information in officers' evaluations is routinely monitored and no significant gender differences have been reported. Therefore, this analysis focused on narrative material. A content analysis was conducted of statements appearing in the comments section of the fitness reports. This section typically includes observations about the manner in which the officer performed duties during the rating period, personality traits, leadership ability, contributions to the command's mission, unique traits, and other characteristics. Comparisons were made of the frequency with which typical phrases or words were used to describe men or women. In addition, an effort was made to determine the practical implications of any gender differences that might result.

The results showed that men's evaluations contained more narrative material than did women's. In particular, more comments were made about their potential performance in combat, the impact of their efforts upon the Navy or command, and recommendations for future assignments. The actual words used to describe officers of each gender also differed. Men, more so than women, were reported to be effective in training others, have the characteristics of a naval officer, be concerned with physical fitness, have a supportive spouse, and have improved the readiness, facilities, and safety conditions at their commands. Women, more so than men, were described as being supportive of equal opportunity programs, impeccable in uniform, and an asset to their command.

To determine whether such gender differences could have an effect on selection board decisions, two narratives were created from the words and phrases used with greatest frequency to describe women or men. No reference to gender appeared in these naratives. Mid-level naval officers reviewed these two psuedo-evaluations and overwhelmingly recommended that the officer described in male terms be promoted.

JUDGMENTS OF PROMOTABILITY		
	CHOICE	
JUDGES	MEN	WOMEN
POSTGRADUATE SCHOOL	46	7
PCO/PXO CLASS	12	2

Utilization and Impact

The results of this investigation are being used to raise the awareness of career officers and to train junior officers who will be writing fitness reports for their subordinates. In addition, the latest edition of the Navy Equal Opportunity Manual discusses the research, to alert managers to the unconscious habits they may have adopted in evaluating women and remind them of their responsibility to become better informed about female career progression.

Research and Development Notes

This research was sponsored by the Deputy Under Secretary of the Navy and funded in Exploratory Development Program Element 62763N, Personnel and Training Technology. It was the last in a series of projects performed under the work unit Personnel Assimilation and Supervision. The objective of this work unit was to identify the individual and organizational factors inhibiting the full utilization of minorities and women in the Navy. The responsible researcher was Patricia Thomas, Navy Personnel Research and Development Center (NAVPERSRANDCEN) (Code 62), (619) 225-2396.

Previous reports published under this work unit include:

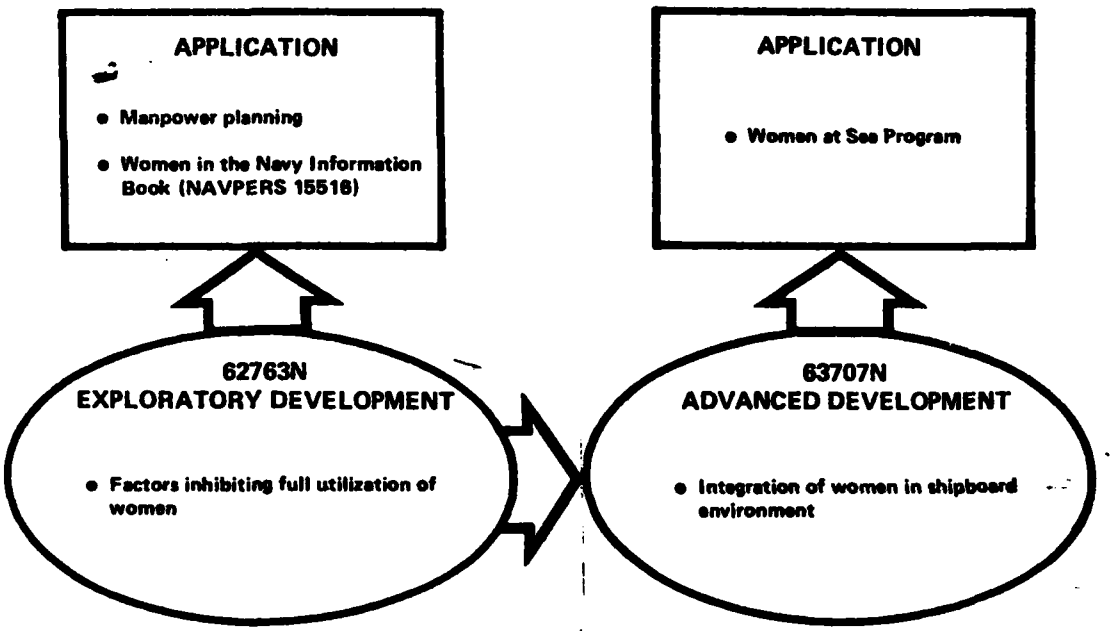
- NAVPERSRANDCEN Technical Report (TR) 78-12, *Women at the Naval Academy: The First Year of Integration*.

- NAVPERSRANDCEN TR 78-35, *Pregnancy in the Navy: Impact on Absenteeism, Attrition and Workgroup Morale.*
- NAVPERSRANDCEN TR 80-50, *Navy Women in Traditional and Nontraditional Jobs.*

Additional information may be obtained from MATRIS by using the following indexing vocabulary:

- Primary Terms:
  - 5.02.23 Male/Female Performance Assessment (Mixed-Sex Units)
  - 5.05.02 Officer Performance Evaluation (Systems)
  - 2.02.04 Equity (Selection Bias)
- Secondary Terms:
  - 6.08.15 Discrimination (Racial, Institutional)
  - 6.07.01 Sexual Inequality Issues
  - 6.03.09 Sex Bias (Sex Role Stereotypes)
  - 8.02.24 Promotion (Volume)
  - 5.13.01 Content Analysis (Narrative Evaluation)
  - 2.02.17 Equal Employment Opportunity (EEO)

Program dynamics are:



RETENTION PLANNING MODELS

Need

The military services are faced in the 1980s with a declining population of youth in the age group from which new personnel are most desirably recruited for military service. Therefore, the retention of personnel already in the enlisted force will be a key factor in determining the Navy's ability to maintain a force level and skill mix necessary to fulfill its mission. In spite of increased retention in recent years, the Navy continues to be critically undermanned in specific ratings such as Sonar Technician and Fire Control Technician. Comprehensive retention planning models are necessary in order to assess the influence of alternative policies on the career commitment of individuals with critical skills.

Approach and Results

A methodology has been formulated to describe the career continuance behavior of enlisted personnel, based upon current or recent historical data. The Graphical Analyses of Survival Probabilities (GASP) uses this methodology to estimate 30-year survival curves from data that span as little as one fiscal year. An advantage of this methodology is that future estimates are based upon the most recent attrition and survival data. GASP estimates and plots over 900 different survival patterns. Estimates can be developed for various population and rating groupings based upon data from selected fiscal years. Trends in retention patterns as well as comparisons of manning between subgroups of the force may easily be assessed.

The project has also developed methods to forecast retention based on policy and population variables. Preliminary models forecast first term retention based on age at entry, educational level, mental group, race, sea duty, and number of dependents. An attribute of these models is the capability to make forecasts using factors which vary at different times, such as the number of dependents. The model will be

expanded to include additional variables and will be extended to the entire career. Thus far, this effort has produced estimated survival curves which have demonstrated the impact of demographic and situational variables upon career behavior. Estimated survival has been found to be dependent upon sea/shore rotation patterns, demographic attributes, rating assignment and various other factors. Differing trends in the behavior of high school and non-high school graduates has been observed, along with survival patterns of various ethnic subgroups.

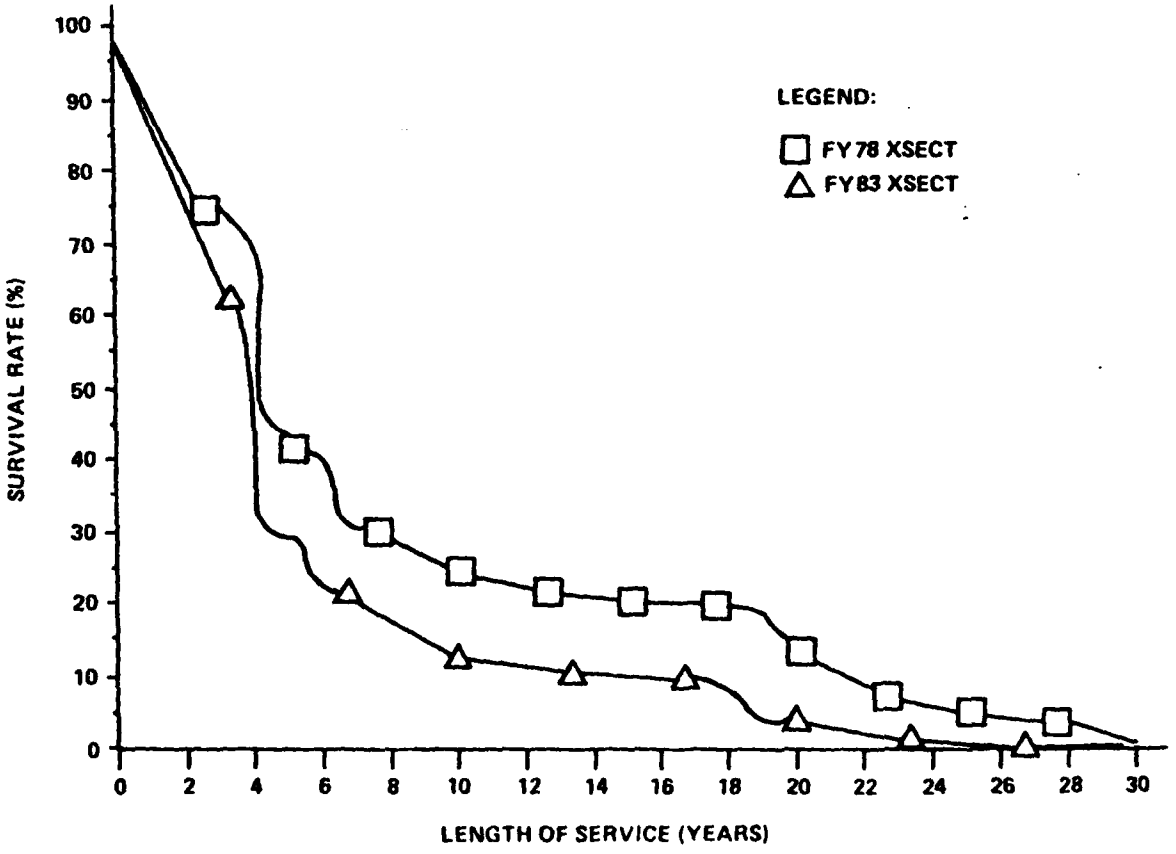
Finally, this effort has contributed to the development of an enhanced personnel tracking system by expanding the Enlisted Survival Tracking File (STF) to include data which facilitate tracking of an individual from proposed rating assignment to ultimate completion of career. This development greatly increases the ability of the Navy to develop accurate attrition and retention estimates at the rating level.

Utilization and Impact

The GASP system was developed in FY82. Demonstrations were conducted in April 1982 for personnel in the Office of the Chief of Naval Operations (Manpower, Personnel and Training) (OP-01) and in the Naval Military Personnel Command. Since then, GASP has been enhanced to include many additional curves and a new means for requesting information from the system. Survival data from GASP have been used by OP-01 to estimate accessions needed for recruit training. The system also has been used to examine career trends of educational subgroups. The prototype GASP system is operational. The accompanying figure illustrates estimated GASP career curves based upon the FY78 force versus the FY83 force.

Specific capabilities provided by Retention Planning Models are:

- Ability to quickly estimate career continuance from recent data.
- Ability to quickly determine differences in the career behavior of subpopulations.
- Ability to easily identify career trends.
- Ability to forecast 20-year survival curves based on demographic and policy variables.



GASP NAVY ENLISTED SURVIVAL CURVES – FISCAL YEAR 1978 FORCE VERSUS FISCAL YEAR 1983 FORCE

- Improved accuracy and capability to incorporate a wide range of monetary and non-monetary variables into forecasts of retention.

Research and Development Notes

This work has been conducted by Mr. R. Hans Mumm and Dr. Michael Nakada, Navy Personnel Research and Development Center (NAVPERSRANDCEN) (Code 61), San Diego, California, 92152, (619) 225-2371. This project was funded under RF63-521-001-804-03.17, Retention Planning Models, in Program Element 62763N, Personnel and Training Technology.

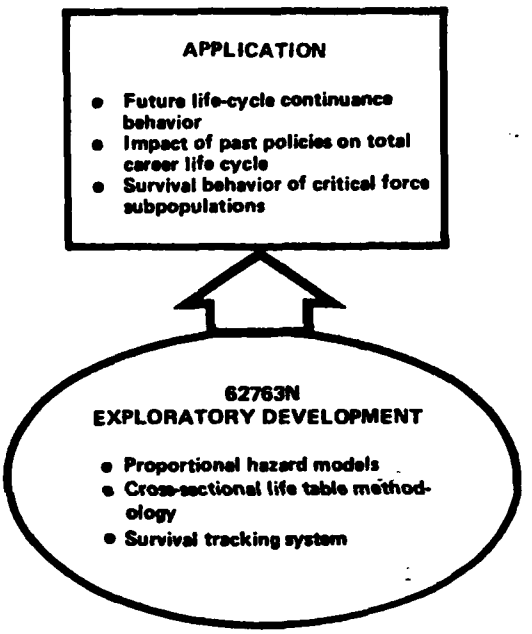
Publications include:

- NAVPERSRANDCEN Technical Note (TN) 82-27, *The Enlisted Survival Tracking File (STF): A Revision*, Gay, K., Borack, J., September 1982.
- NAVPERSRANDCEN Special Report (SR) 83-24, *A Digest of Retention Terms: Definition and Historical Values*, Nakada, M., Mumm, R., and Curtis, E., April 1983.
- NAVPERSRANDCEN Technical Report (TR), *A Dynamic Model of Navy Enlisted Retention*, Nakada, M., Forthcoming.
- NAVPERSRANDCEN (TR), *The Graphical Analyses of Survival Probabilities (GASP) Methodology and User's Guide*, Mumm, R., Forthcoming, Unclassified.

Additional information can be obtained from MATRIS using the following indexing vocabulary:

- Primary Terms:
  - 8.01.20 Personnel Projection/Forecasting Model (Officers)
  - 8.01.01 Manpower Planning Models, Military
  - 8.02.19 Retention
  - 8.03.11 Retention Rates
- Secondary Terms:
  - 8.01.23 Manpower Supply Forecasting
  - 8.08.03 Manpower Management Techniques (Mathematic, Econometric)
  - 8.03.07 Manpower Policies (Incentives/Advancement/Retirement)
  - 8.02.04 Job Specialty/Skill Imbalance (Prediction, Management)
  - 8.03.08 Skill Classes (Substitution, Shortages)
  - 2.02.07 Demographic Criteria

Program dynamics are:



FORECASTING OFFICER LOSS BEHAVIOR

Need

Personnel losses play a pivotal role in military manpower planning. By creating vacancies, losses trigger accession and promotion actions. Collectively, these personnel flows control the size and shape of the force. An underestimate of losses can lead to too few accessions and promotions, erroneous budget projections, and ultimately a degradation of personnel readiness in the Fleet. In contrast, an overestimate can result in too many accessions, delayed promotions, and potential budget violations. Unfortunately, the uncertainty of forecasts increases dramatically with time, that is with the length of the forecast horizon. Loss forecasters are unsure whether the correct variables have been captured in forecasting methodology. Even more uncertainty exists that relative contributions of these variables (e.g., unemployment, pay) have been accurately measured. But, more importantly, in multi-year forecasts, the values of these variables are not likely to be known, at least not with much certainty. Most forecasters have dealt with this latter form of uncertainty by assuming that current conditions would hold over the entire forecast horizon. In other words, the first year forecast is straightlined. In recent years, however, when loss rates have achieved extreme lows, there has been question as to whether or not this approach prevents large errors in the outyears. Instead, forecasters need a method that avoids large errors. This is because relatively small errors can be overcome with special programs (e.g., early-outs) and incentives, but large errors require more significant measures (e.g., budget reprogramming).

Approach and Results

In response to this need, the "wear-off" method of multi-year forecasting was developed. The method assumes that,

other things being equal, the forecast value has a tendency to migrate or "wear-off" over time to some historical average, especially if the initial forecast represents either extreme of an historical range of values. This strategy is essentially conservative in that, in the absence of overriding knowledge, forecasts of loss rates should be close to historical averages as uncertainty (time) increases. The period of migration is dependent on the variability of the historical rates, as measured by their coefficient of variation and the average time between crossovers (passage of the rates above or below the mean). The wear-off method has been used to forecast the outyear loss rates for all Navy officer communities. The accompanying figure illustrates the FY82-88 estimates for pilot community. It shows the first year forecast (FY82), based upon explicit guidance about expected pay raises and external employment conditions, and the derived, four-year linear wear-off function. The forecast migrates to a baseline, e.g., the simple average of the historical data. The loss rates increase by one-fourth of the difference between the first year estimate and the baseline in FY83 through FY86 and remain at the baseline in FY87-88.

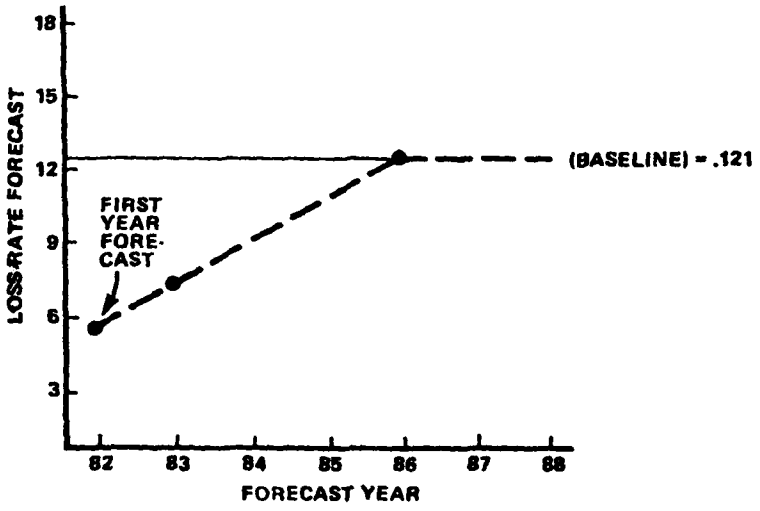
Utilization and Impact

The wear-off methodology is embedded in the Officer Retention Forecasting Module (ORFM), a component of the Navy's primary officer manpower planning system, STRAP-O. It is employed frequently to make multi-year loss forecasts in support of budget development exercises, steady-state inventory projections, and long-run assessments of manpower objectives and policies. The wear-off method has been and will continue to be used to help manpower managers avoid costly loss forecast errors.

Research and Development Notes

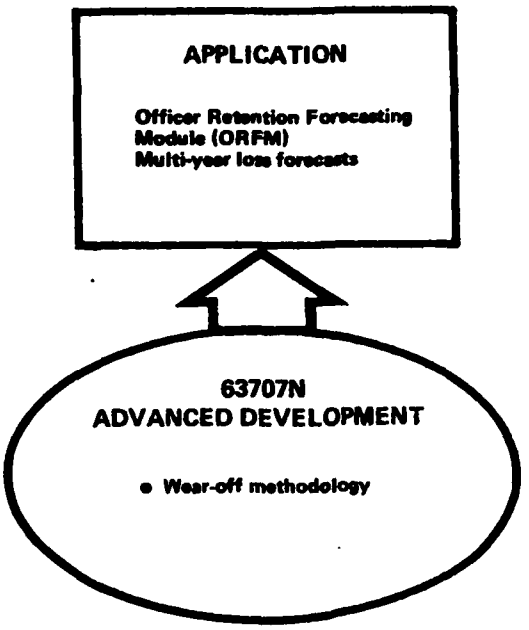
The project was performed by the Manpower Management Systems Research department at the Navy Personnel Research and Development Center (NAVPERSRANDCEN), San Diego, California, 92152, (619) 225-7388. The researcher responsible for the wear-off methodology is Mr. Barry Siegel. The effort was funded from Program Element 63707N, Manpower Control Systems Development, within Subproject Z1187-PN.02, Officer Personnel Management Models of Project Z1187-PN, Computer-based Manpower Planning and Programming. NAVPERSRANDCEN Technical Report (TR) 83-30, Methods for Forecasting Officer Lost Rates, August 1983, documents the effort. Additional information is available from MATRIS by using the following indexing vocabulary:

- Primary Terms:
  - 8.01.04 Manpower Loss Forecasting/Projection Techniques (Costs)
  - 8.02.03 Personnel Inventory Losses, Prediction
  - 8.01.20 Personnel Projection/Forecasting Model (Officers)
  - 8.01.01 Manpower Planning Models, Military
- Secondary Terms:
  - 8.01.13 Enlisted Forecasting (Geographic Region)
  - 8.01.23 Manpower Supply Forecasting
  - 13.01.18 Officer Personnel



LOSS RATE FORECASTS (1982 – 1988) FOR PILOTS

Program dynamics are:



DEPARTMENT OF THE NAVY FAMILY ADVOCACY PROGRAM

Need

During the early 1970s, increased awareness of child maltreatment prompted the Surgeon General of the Navy to advocate a program dealing with both the medical and social aspects of the problem. In 1976, the Chief, Bureau of Medicine and Surgery (BUMED), now Commander, Naval Medical Command (NAVMEDCOM), established within the Navy Medical Department the Child Advocacy Program for the protection of dependent children who were abused, neglected or abandoned. In 1979, the BUMED program was expanded to include spouse abuse and neglect, sexual assault, and rape, and was redesignated the Navy Family Advocacy Program (FAP). In 1981, responsibility for the Family Advocacy Program was assigned to the Deputy Chief of Naval Operations (Manpower, Personnel and Training) (OP-01), Human Resources Division (OP-15).

The Family Advocacy Program addresses prevention, evaluation, identification, intervention, treatment, follow-up and reporting of child abuse, spouse abuse, and sexual assault. To accomplish this task, data and information must be obtained with which to guide future policy and direction. A complete assessment was needed to draw conclusions and coordinate the required research and development.

Approach and Results

A three pronged approach developed the needed data base. First, a complete review was conducted of the scope and nature of abuse and neglect as reported in available military and civilian literature. Second, the structure and operation of the Navy Family Advocacy Program at the command level was evaluated. Finally, conclusions were drawn from which testable hypotheses and suggested areas for further empirical investigation could be generated.

Site visits were made to thirteen Navy and Marine Corps installations. Interviews were conducted with a broad spectrum of Department of the Navy community personnel at each site. The data accumulated from these visits and interviews resulted in definition of major program strengths, concerns, and dilemmas. It also enabled identification of program needs and development of recommendations for program improvements.

Utilization and Impact

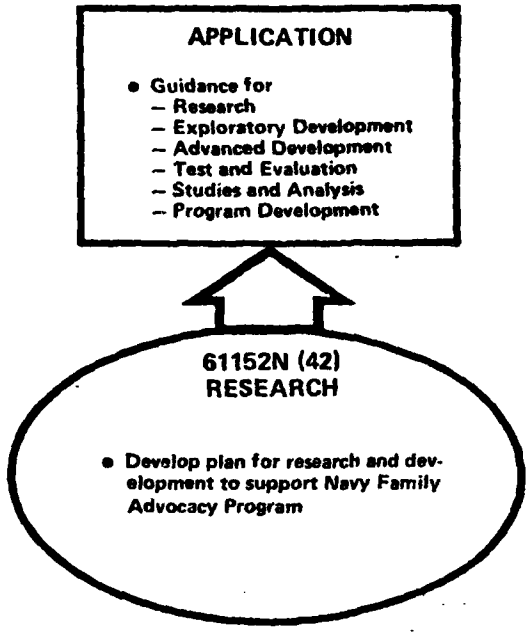
The information which was gathered is serving several valuable functions. It provides a much needed source of reliable and useful information to guide the program into the future. This is extremely important because it allows continuity in the Family Advocacy Program. Also, it provides a brief summary of the available literature on child abuse and spouse abuse, sexual assault and rape, and an overview of the military family advocacy programs. It therefore has become a resource manual for people active in the program at the local level. Further, the study serves as a generic model for planning and will improve the program's operation and its ability to adapt to the future.

Research and Development Notes

This work was sponsored by the Navy Family Advocacy Program and managed by the Office of Naval Research (ONR) through its Organizational Effectiveness Research Programs. Dr. Bert T. King, ONR (Code 4420E), (202) 696-4503 was the scientific officer. It was funded in Program Element 61152N, In-House Laboratory Research, Subelement 42, Behavioral and Social Sciences, Project RR042-08, Organizational Effectiveness. It was performed by SRA Technologies Incorporated in Arlington, Virginia with Dr. Gary L. Bowen as the principal investigator. The effort was coordinated with and advised by representatives from the Navy Family Support Program; Headquarters, U.S. Marine Corps; Naval Medical Command; Naval Military Personnel Command; and the Military Family Resource Center. The work has been documented as Dr. G. L. Bowen, *Department of the Navy Family Advocacy Program: Service Need and Service Response* (Phase I Report: *Reconnaissance*, Phase II Report: *Assessment*, Phase III Report: *Summary and Conclusions*), SRA Technologies Incorporated, Arlington, Virginia; October 1983. Additional information can be obtained from MATRIS using the following indexing vocabulary:

- Primary Terms:
  - 6.04.32 Family (Harmony/Disharmony)
  - 6.11.06 Psychiatric/Mental Health Services
  - 6.03.08 Maladjustment Factors
  - 6.11.11 Health Services Effectiveness Criteria
- Secondary Terms:
  - 6.03.12 Psychiatric disorders/Mental Illness
  - 6.08.17 Family Separation/Reintegration
  - 6.08.18 Military Sociology
  - 11.01.24 Medical Data Files

Program dynamics are:



MICROFICHE TITLE GENERATION SYSTEM

Needs

Naval military personnel records are converted to microfiche images by the Military Personnel Records System (MPRS) at the Naval Military Personnel Command (NMPC). The developed film images are then reviewed to determine field code categories, a batch sequence number is assigned to each image, and pertinent information is entered into a Process Control System (PCS) data base for later use throughout the MPRS. The images are appended to the next available space (98 image spaces available per master fiche) in the service member's master fiche which is identified by a title label readable by a human and a machine. The title is on a semi-permanent pressure sensitive paper stock label which is automatically impact printed via a link to the PCS. The title labels are then manually affixed to the top of the microfiche master. Handling, duplication and general file maintenance eventually wear the printed characters on the title to such an extent that discernible diazo duplicates for requestors cannot be produced. (All master record copy requests for users are duplicated on diazo medium.) Thus, title labels must be periodically regenerated. This is an expensive, labor-intensive process for which improvements are required.

Approach and Results

The on-site contractor that operated the MPRS from its inception to March 1983 identified new technology for an archival quality title generation process, and recommended that the feasibility of an improved title generation system be examined. Also, NMPC plans for acquisition of new modern microfiche mounter/certifiers and automatic microfiche sorters require a machine-readable title. Therefore, action was initiated to determine the viability of developing a semi-automatic title generation system which would be capable of producing human-readable, machine-readable (HRMR) labels on a more durable medium. The concept which was examined included an optical title generating device, an automated title mounter, and a method of removing existing paper labels.

As a result of this work, a title removal process was discovered that could mechanically eradicate the title legend

and translucent label finish to achieve a transparent residue-free area through which the newly affixed transparent polyester label would be visible and legible. Also recommended was a title generation process which used an on line photocomposition procedure for exposing each character individually onto 16mm silver halide roll film. The exposed file would subsequently be processed and treated with a protective emulsion overcoat. Using a double adhesive, the file title would then be cut to size and mounted to the microfiche carrier in the same manner employed to mount record imagery.

Utilization and Impact

Microfiche titles generated with the improved system will be duplicable with greater clarity than is possible with the existing method. Also, characters and bar codes will realize greater readability, durability, and opacity retention. The final product will enhance the automation of many current manual processes and improve record handling. It should virtually eliminate label replacement and reduce read-error rate, thus significantly reducing operating costs. Overall system efficiency should be improved.

The upgraded HRMR microfiche title label should enhance the future automation of current manual processes by permitting various scanning technologies to be better employed for transmitting fiche and record identification, and should further economize routine record handling. A full economic analysis will be conducted to determine whether or not to procure the system.

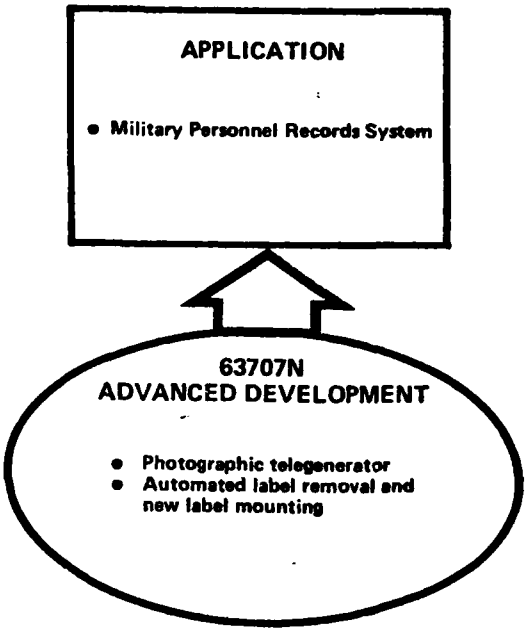
Research and Development Notes

This work was sponsored by the Deputy Chief of Naval Operations (Manpower, Personnel and Training) (OP-01), and conducted by Planning Research Corporation/Dynak Corporation through a contract awarded by the David Taylor Ship Naval Research and Development Center. It was identified as Project W1584-PN, Improved Personnel Records System, in Program Element 63707N, Manpower Control System Development.

Additional information can be obtained from MATRIS using the following indexing vocabulary:

- Primary Terms:
  - 11.02.11 Data Base Maintenance (Updating, Purging)
  - 11.01.19 Human Resources Management Data Base
  - 3.06.15 Microfiche (Applications)
  - 11.01.14 Manpower Data Files (USMC)
- Secondary Terms:
  - 11.02.02 Data Bank System Concepts
  - 11.01.15 Manpower Management Information Systems (OSD, MAPMIS)
  - 11.01.19 Advanced Personnel Data Systems (APDS, PROMIS, GTEP)
  - 11.01.04 Human Resource Management Systems
  - 11.02.01 ADP Equipment Maintenance/Operational Support

Program dynamics are:



EDUCATION AND TRAINING

This area of People-Related RDT&E is defined in the Department of Defense as the "Development of education and training methods and media for managing, designing, and evaluating new-generation instructional systems for military applications."

The Navy training establishment faces major challenges in trying to maintain personnel readiness to meet operational demands while it is faced with economic restrictions, manpower competition, and the increasing sophistication of weapons. New technology is being developed to focus training objectives on actual job requirements, to reduce training costs and improve efficiency, to improve the availability of training, and to adapt training to the needs of the individual.

The projects summarized in this Annual Report are:

- **Enlisted Personnel Individualized Career System (EPICS): An Integrated Personnel Systems Approach**
- **Acquisition of Vocational and Technical School Graduates as a Manpower Source**
- **U.S. Marine Corps Professional Military Education**
- **Remote Sites Training Using Microprocessors**

ENLISTED PERSONNEL INDIVIDUALIZED CAREER SYSTEM (EPICS): AN INTEGRATED PERSONNEL SYSTEMS APPROACH

Need

The Navy continues to face such problems as increasing training costs and ever-tightening budgets, along with the need to man complex systems with highly technically qualified personnel. Specific concerns include long and congested training pipelines, skill and knowledge deterioration, lack of effective shipboard skills training, and less than fully effective use of available personnel capabilities.

Approach and Results

In response to those concerns, an Integrated Personnel System Approach (IPSA) (Figure 1) was employed to develop the Enlisted Personnel Individualized Career System (EPICS) (Figure 2) which reduces training costs by deferring shore-based training. It provides apprentice personnel with on-the-job experience, complemented with job performance aids (JPAs) and self-paced instructional materials. Those personnel who have completed apprentice technician duty and demonstrated satisfactory job performance to their supervisors are sent to shore-based equipment technician training (ETT) and, if they continue to progress, to system technician training (STT). Thus, the EPICS program integrates technical progress, shipboard adjustment, and educational opportunities into an individualized career path.

The EPICS concept is being tested through a longitudinal field implementation and is being compared to the conventional personnel system (CPS) training pipeline. The NATO SEASPARROW Surface Missile System (NSSMS) is the EPICS test vehicle. The particular occupational rating that maintains this system is the Fire Control Technician (Surface Missile) (FTM). The 146 EPICS personnel completing recruit training were assigned to 30 DD 963 Class ships and to 4 CVs and were divided equally between the Pacific and Atlantic Fleets. Approximately half of the personnel were ineligible for the FT rating schools, based on the selection criteria of Armed Service Vocational Aptitude Battery scores.

The evaluation assesses the overall cost effectiveness of the various initiatives and approaches that make up EPICS. It also appraises the value of EPICS as an alternative to current technical career paths. Specific evaluation areas included are:

- Cost effectiveness of deferring training compared to existing front-end loaded training.
- Efficacy of providing initial skills training on board ship.
- Progress of FT technical school eligible and ineligible personnel through the EPICS career path.
- Effectiveness of JPAs in terms of skill enhancement value.
- Acceptance by Fleet personnel, and cost.
- Utility of self-teaching "exportable" training modules on board ship in building competence and facilitating individual career progression.
- Program impact on personnel motivation, attrition, career progression, and retention.

Preliminary findings indicate that the EPICS path appeals to General Detail (GENDET) recruits in all aptitude categories. In the first eighteen months of enlistment, EPICS Navy attrition was 50 percent less than a comparison GENDET group and about equal to that of an FT group (8 percent). Disenrollment from EPICS (77 percent of total

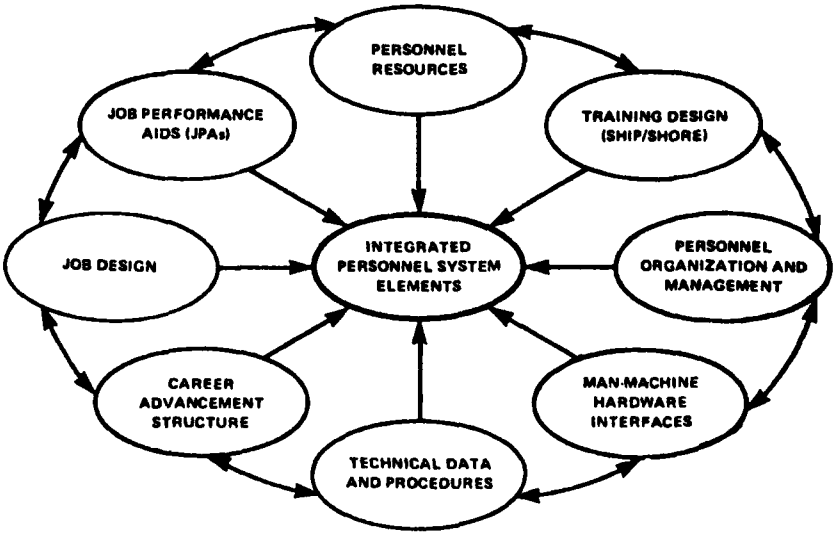


Figure 1. OVERALL IPSA CONCEPT

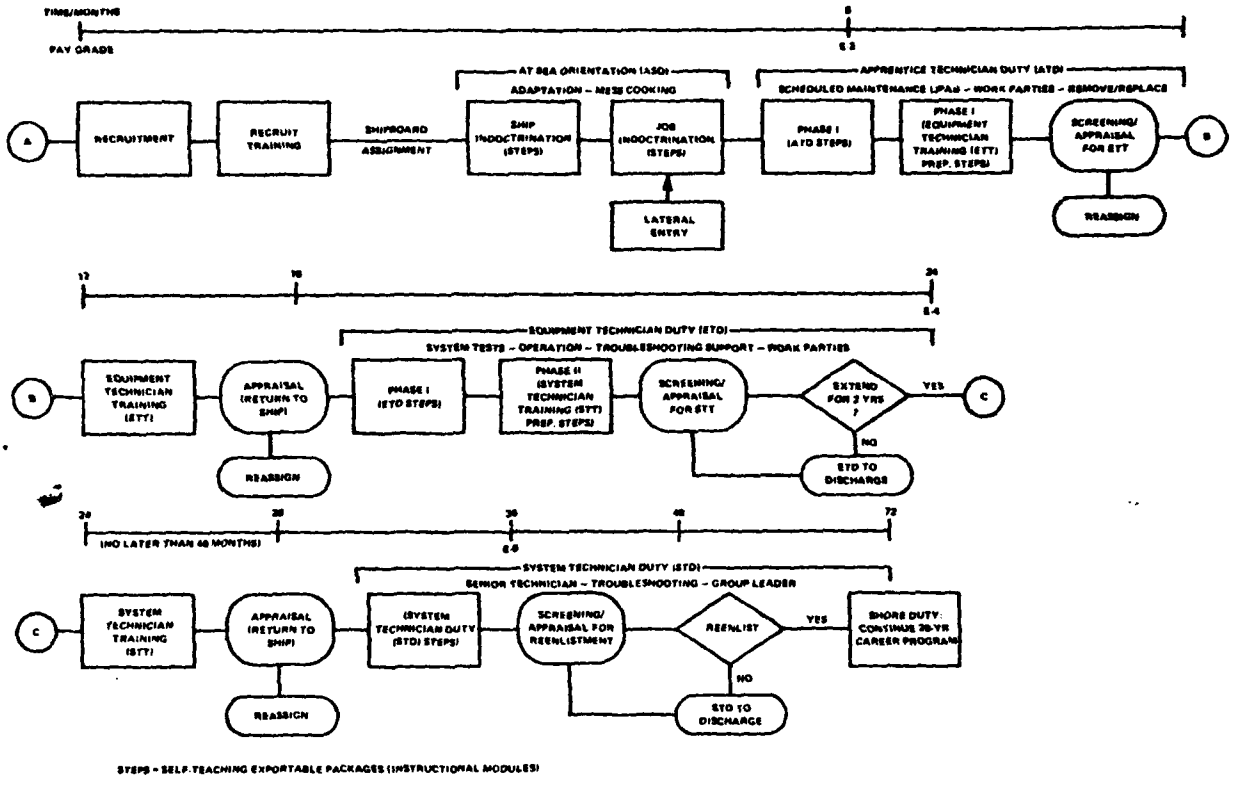


Figure 2. EPICS 6-YEAR CAREER SYSTEM MODEL

attrition) generally occurred prior to the first shorebased training investment. Disenrollment from the EPICS program to deck force or other ratings was 24 percent of the entire EPICS group. Total attrition from the FT-ineligible group was less than that from the FT-eligible group, although the difference is decreasing. Attrition trends suggest that the relatively high-risk periods occur within the first twenty-four months. Risk level for the remainder of the program should be considerably less.

Comparisons between Basic Electricity and Electronics (BE&E) students and EPICS Equipment Technician school students indicated that the FT-eligible students who completed the twenty-five instructional modules had a faster course completion time than did the FT-track BE&E group and the EPICS FT-ineligible group (see Figure 3). Those EPICS FT-ineligible students who completed the twenty-five instructional modules also had faster course completion times than the BE&E group. These results are tempered by factors that confound the data. Therefore, data will continue to be collected to determine the final number of individuals in each subgroup who can be considered successful at this training episode.

JPAs were considered helpful by Fleet supervisors in aiding maintenance performance of EPICS personnel, although EPICS personnel quickly transferred to the use of conventional maintenance cards because they constituted the "peer-accepted" documentation. Further, the apprentice level JPAs were considered more detailed than necessary.

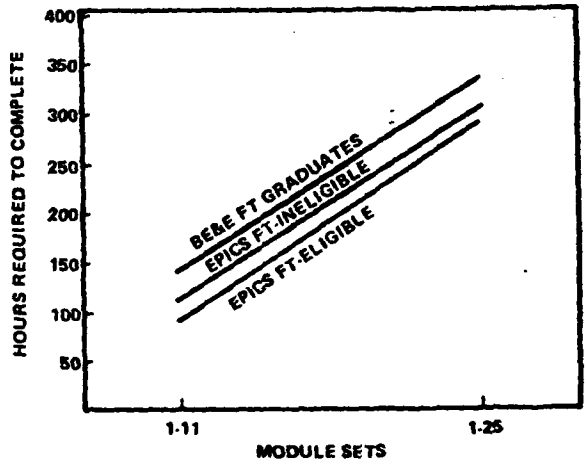


Figure 3. HOURS REQUIRED TO COMPLETE BE&E MODULE SETS FOR EPICS GROUPS AND FT-TRACK BE&E GROUP

Supervisors also considered the self-teaching exportable modules used on board as a useful and viable approach to competency building. However, some EPICS personnel noted the typical problem of finding time and acceptable study locations on board ship. Completion of school preparatory modules requires self-discipline and commitment on the part of each individual. Those without these attributes tended to have greater difficulty in the program.

The quality of shipboard administration of EPICS varied from ship to ship. Supervisory effectiveness and encouragement, particularly at the work center level, directly influenced progress made by many EPICS personnel. Special EPICS Fleet representatives supported by the project office were helpful in ensuring supervision, but variation in supervisory quality is a reality of shipboard life and requires adjustment by EPICS personnel in a self-paced instructional program.

Cost analyses contrasting EPICS with the current technical career path (BE&E, "A", and "C" schools) indicates a potential 30 percent cost avoidance using a deferred distributed personnel system such as EPICS. This savings might be increased further if less detailed JPAs are required, because the JPA cost will be less. In addition, there appears to be a potential 3-to-1 advantage in manpower utilization by tapping the "school-ineligible" pool.

Shipboard work contribution has been broadly conceived as an aggregate measure of time spent on shipboard activities performed. As representative of this measure, scheduled weapon system maintenance work has been evaluated for EPICS and CPS (see Figure 4). In addition, supervisory ratings indicate little difference in confidence in technical task assignment between EPICS FT-eligibility groups prior to their first school and A-school graduates. It appears that EPICS personnel can become operationally productive earlier in their enlistment at a lower cost.

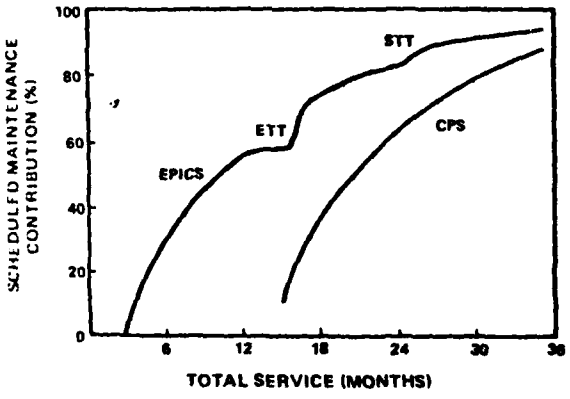


Figure 4. **REPRESENTATIVE SCHEDULED MAINTENANCE CONTRIBUTION FOR EPICS AND CPS**

EPICS test and evaluation data will continue to be gathered through the completion of EPICS personnel enlistments. Interim and final evaluation analyses and findings illustrating personnel, program, and cost effectiveness benefits and tradeoffs will be reported through FY86.

Impact

EPICS has generated interest from a number of operational organizations. For example, Fleet feedback through commanding officer narrative reports has been generally positive, with some recommendations for expanded applications. Furthermore, several application opportunities have arisen as manifested by:

- Requests from the NATO SEASPARROW Project Office for implementation and expansion.
- Direction by Office of Chief of Naval Operations to implement EPICS on NSSMS ships.
- Recommended expansion to the departmental level in support of the Naval Training Improvement Program (NAVTIP).
- Interest in the Office of the Chief of Naval Operations in developing an EPICS-like program for FTs to the FT-0000 level.
- Navy Manpower and Material Analysis Center recommendation to implement.
- Chief of Naval Reserve and OP-03R interest in the program for the Naval Reserve.
- Various Type Commander interest in EPICS and a number of EPICS-like programs.

It is apparent that EPICS addresses personnel issues with broad and far reaching implications for the Navy manpower, personnel and training community. The applicability of EPICS for these potential users and the efficacy of an IPSA approach for other occupational ratings, ship platforms, and Navy communities should be investigated.

Research and Development Notes

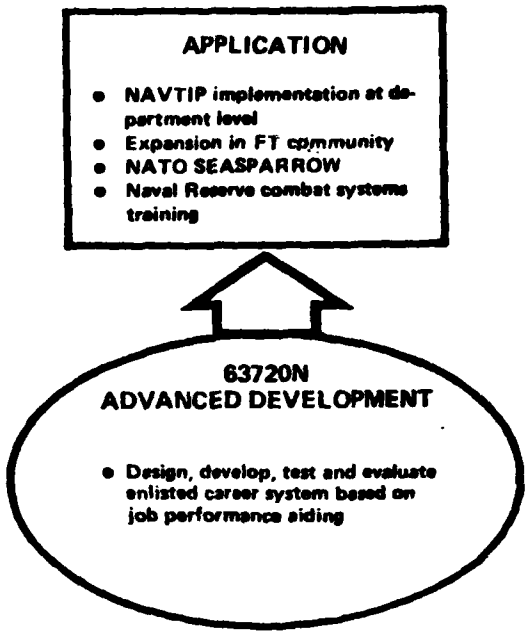
This project is being performed by the Navy Personnel Research and Development Center (NAVPERSRANDCEN), San Diego, California, 92152. The title of the project is Enlisted Personnel Individualized Career System (EPICS), Z1772.001, in Program Element 63720N, Education and Training. The responsible researcher is Dr. Harry B. Conner (Code 52), (619) 225-6721. The project was initiated in FY75 and will be completed in FY86. There have been several Technical Reports (TRs), Technical Notes (TNs) and Special Reports (SRs), of which the following are descriptive of EPICS and indicate some findings:

- NAVPERSRANDCEN TN 80-14, *Integrated personnel systems approach (IPSA): The enlisted personnel individualized career system (EPICS) model*, Blanchard, R. E., and Smillie, R. E., May 1980.
- NAVPERSRANDCEN TR 84-15, *Enlisted personnel individualized career system (EPICS): Design, development and implementation*, Blanchard, R. E., Smillie, R. J., and Conner, H. B., January 1984.
- NAVPERSRANDCEN TR 84-16, *Enlisted personnel individualized career system (EPICS): test and evaluation interim report*, Blanchard, R. E., Clelland, I. J., and Megrditchian, A. M., January 1984.
- NAVPERSRANDCEN SR 83-23, *Enlisted personnel individualized career system (EPICS) and conventional personnel system (CPS); Preliminary comparison of training and ancilliary costs*, Megriditchian, A. M., April 1983.

Additional information may be obtained from MATRIS using the following indexing vocabulary:

- Primary Terms:
  - 6.13.04 Personnel Management/Assignment Systems (EPMS, OPMS)
  - 6.01.02 Career Development Systems/Programs (Military/Civilian)
  - 3.02.24 Technical Training
  - 10.10.01 Job Performance Aids Development
- Secondary Terms:
  - 2.06.01 Initial Assignment, General
  - 6.01.09 Career Development Program, Design/Evaluation (Enlisted)
  - 4.05.06 Training Systems Management (Field Exercises, Shipboard)
  - 3.04.15 On-the-job Training (OJT)
  - 5.02.10 Shipboard
  - 3.15.13 Training Methods Evaluation
  - 3.09.13 Training Modules (Automated, Adaptive, Aircrew)
  - 3.05.05 Training Cost Analysis (Savings, Cost Avoidance)
  - 8.02.07 Marginal Manpower, Utilization
  - 3.03.02 Remote Site (Shipboard)

Program dynamics are:



ACQUISITION OF VOCATIONAL AND TECHNICAL SCHOOL GRADUATES AS A MANPOWER SOURCE

Need

Analyses of population demographics have indicated that over the next decade the Navy will face an approximate 19 percent decline in the manpower pool from which it draws. In addition, available funding for technical training conducted by the Navy is continually decreasing in proportion to the need. The likelihood of acquiring and training the personnel needed to meet the manpower requirements of the 1990s is questionable if current accession and training methods are to remain the only sources. The present shortage of skilled petty officers and the time required to recover from that shortage using traditional recruitment and advancement training warrants the investigation of supplemental manpower training and accession sources.

One potential method for augmenting the quantity and quality of skilled manpower is to recruit graduates of community vocational and technical (VOTECH) colleges as petty officers.

Approach and Results

There are four phases in the project. The first phase involves an analysis of the vocational and technical schools' current and potential ability to provide training comparable to that offered at the Navy's technical schools. The Navy Personnel Research and Development Center (NAVPERSRANDCEN) surveyed approximately 1,900 schools inquiring as to the interest in a program designed to access their qualified graduates as Navy petty officers. The response was extremely positive, with only 17 percent of the nationwide sample declining to participate. Upon return of the survey, each institution expressing interest is recontacted and requested to forward curriculum brochures for comparison with Navy technical school requirements. Based on an analysis of the brochures as compared to Navy requirements, each school is provided with rating (technical occupation) and paygrade accession levels for which their graduates would qualify. Also during this phase, student interest in the program is assessed. Further, the military indoctrination and leadership training requirements of VOTECH accessions will be defined.

During phase two, approximately 35 schools representing various regions of the country will participate in a pilot program. Graduates from these institutions will be recruited into the Navy and their performance tracked over a period of time. In order to control the quality of the accessions, entry into the Navy will be based upon performance on occupational area skill and knowledge exams also being developed at NAVPERSRANDCEN.

The third phase will be the program evaluation. Individuals recruited from the VOTECHs will be tracked for a period of

time and compared with Navy school trained individuals on performance, cost of training and impact on the existing force. Also, a cost-benefit analysis of the program will be conducted.

Finally, during phase four, a feasibility model will be formulated. The model will combine variables such as the available supply of VOTECH recruits, performance evaluation data and Navy manpower requirements, to produce a feasibility ranking for the VOTECH concept by rating and paygrade.

Utilization and Impact

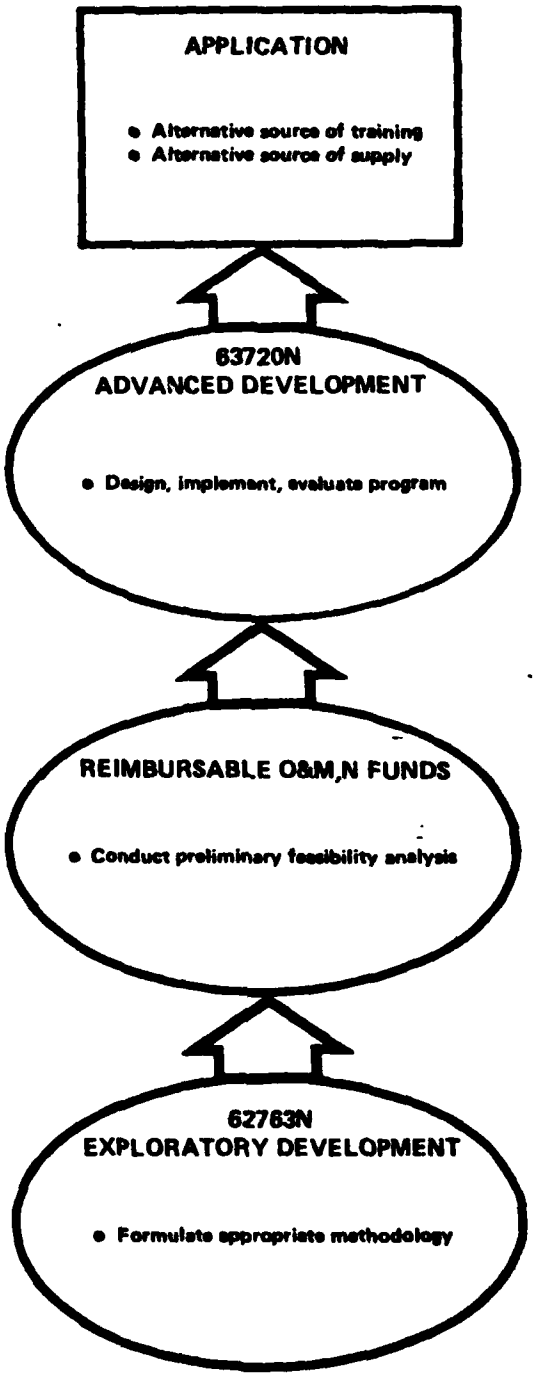
The VOTECH program should result in a method for augmenting both the quantity and quality of skilled manpower, thus relieving to some extent the current Navy school training requirement. The potential cost savings resulting from the program are high. Under the VOTECH effort, no funding will be provided to the schools. Rather, benefits to the schools would include an additional competitive source of placement for graduates and a basis for defending the viability of community vocational and technical college programs even when the local civilian demand for graduates has declined. In addition, VOTECH provides a cost advantage over other recruiting programs in that it will accrue no advertising costs. Preliminary indications from colleges are that they will advertise the program on campus through school newspapers and college counselors.

Research and Development Notes

This work derived from an effort entitled, "Civilian Sector Training for Lateral Entry," which was funded by the Office of Naval Technology during FY82 and FY83 under Program Element 62763N, Personnel and Training Technology, Project Number PF63-522-801-002-03.42. The working title of that program was Lateral Entry Accession Program (LEAP). The principal investigator is Dr. Meryl S. Baker, NAVPERSRANDCEN (Code 52), (619) 225-6955. The VOTECH effort itself was first funded during FY83 by reimbursable (O&MN) funding provided by the Deputy Chief of Naval Operations (Manpower, Personnel and Training) (OP-01). Project VOTECH was not funded during FY84. It is anticipated that the project will be funded in FY85 under Program Element 63720N, Education and Training, Project Number Z1216-PN, Lateral Entry. Additional information may be obtained from MATRIS using the following indexing vocabulary:

- Primary Terms:
  - 1 01.14 Lateral Entry Accessions (Non-Prior Service)
  - 1 01.11 College/Junior College Students
  - 1 03.05 Recruiting Strategies/Practices/Procedures
  - 8 07 06 Personnel Procurement Sources Evaluation
- Secondary Terms:
  - 8 07.05 Accession Policies/Practices Evaluation
  - 1 01 13 Older Population Accessions (Ages 19-23)
  - 1 01 02 Enlisted Recruit Sources
  - 3 01 17 Noncommissioned Officers (NCO's/Petty Officers)

Program dynamics are:



U.S. MARINE CORPS PROFESSIONAL MILITARY EDUCATION

Need

The Education Center of the Marine Corps Development and Education Command (MCDEC), Quantico, Virginia, is responsible for the resident schools at Quantico and also for the non-resident programs administered by the Marine Corps Institute (MCI). These organizations share the responsibility of training Marine Corps officers and Senior Non-Commissioned Officers (SNCOs). The resident schools at MCDEC can accommodate approximately 18-20 percent of all personnel from SNCO to Lieutenant Colonel. Another 10-15 percent of Marine Corps officers has an opportunity to attend the resident courses at career or intermediate levels at other formal service schools. The limited space available in resident schools means that 65-70 percent of all Marine Corps officers and SNCOs must rely on MCI non-resident courses for their professional military education.

The Education Center accomplishes its mission in the sense that nearly all Marine Corps officers receive professional education appropriate to their rank. However, some training inefficiencies exist:

- The group-paced instruction in the resident schools prevents maximum student use of resources. Students must wait for a class to convene rather than simply begin course work upon assignment to a school. Further, some of the longer courses can be offered only once a year under this condition, thus limiting access to prospective students.
- MCI courses are individualized, but the materials used were derived directly from group instruction. They do not provide the full range of activities available in the resident school courses, there are no instructors present to interpret the text materials, and there is no opportunity for those enrolled in non-resident courses to participate in the seminars available to the resident students.
- Although both the resident and non-resident schools employ evaluation procedures, neither has a fully formalized, continual evaluation program. Management, therefore, may be deprived of critical data necessary to make timely operational and instructional decisions.

In essence, the Marine Corps needs to increase the effectiveness of its professional military education (PME) and to achieve greater efficiency in training program development and delivery.

Approach and Results

The research program to enhance Marine Corps PME involved three major phases, the first two of which have been completed.

During Phase I, a prototype individualized instructional program and evaluation system was developed using the instructor's course at the Instructional Management School (IMS) at Quantico, Virginia, during FY82. The purpose of this course is to train the PME instructors on the individualization process, and then to assist them in accomplishing the same processes for the courses they will eventually teach. The accompanying figure presents the lesson structure used in Phase I of the project.

In Phase II, a portion of a resident subcourse of the Marine Corps Command and Staff College curriculum was individualized. An evaluation of this training segment indicated that, in terms of student performance and acceptability, it is feasible to individualize comparable resident professional courses. In addition, a Handbook for Individualized Instruction was developed during FY83 on the basis of experience gained from individualizing instruction at IMS and at the Marine Corps Command and Staff College. This handbook is designed to guide instructors systematically through the tasks that are required for individualization. An associated study guide provides the instructors with opportunities to practice needed skills, focusing on their own course. The materials are designed to stand alone, based on requisite preparation provided at an IMS or similar instructor training facility.

During the final phase, a non-resident subcourse is to be evaluated, incorporating procedures for professional interaction among students and instructors. A portion of the Amphibious Warfare School curriculum is to serve as a test course. Low cost teleconferencing will be used as the pilot medium for implementing the student interaction processes.

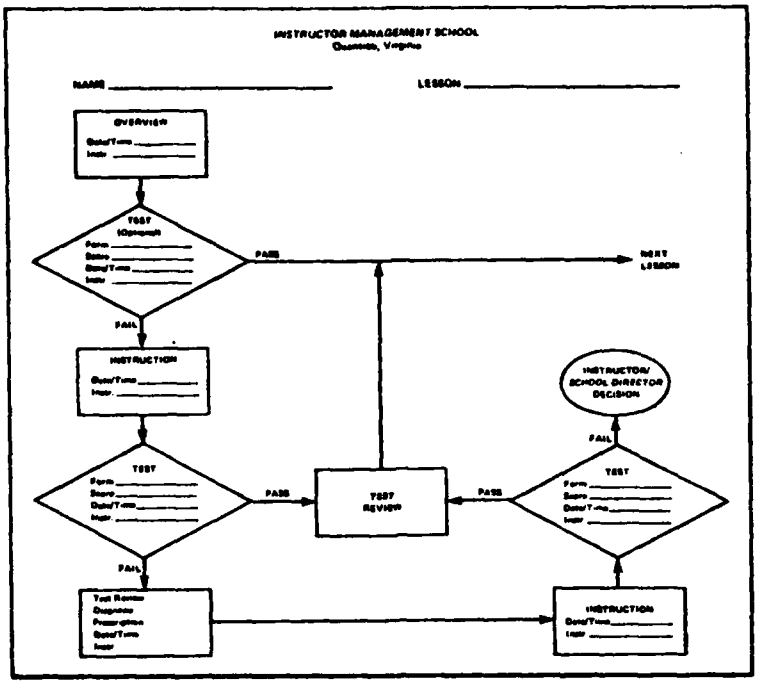
Utilization and Impact

The individualization of instruction at IMS Quantico, Virginia, has demonstrated the feasibility of this approach for increasing the effectiveness and efficiency of instructor training. In the initial evaluation of the revised course, average student training time was reduced from the previously required four weeks to three weeks. Students were able to practice relevant skills more frequently, and the necessary degree of group interaction was retained. Application of individualization strategies to other similar training situations may reduce the cost and time delay factors associated with conventional group-paced training courses.

The Handbook for Individualized Instruction provides graduate instructors with a procedural guide and associated materials necessary to accomplish individualization of instruction for their own courses. This handbook and associated materials have considerable potential for application to other PME courses in the Marine Corps and Navy.

Research and Development Notes

This effort was initiated with support in Program Element 62763N, Personnel and Training Technology, and was identified as Project ZF63-521-080-102. Support is continued in



LESSON STRUCTURE

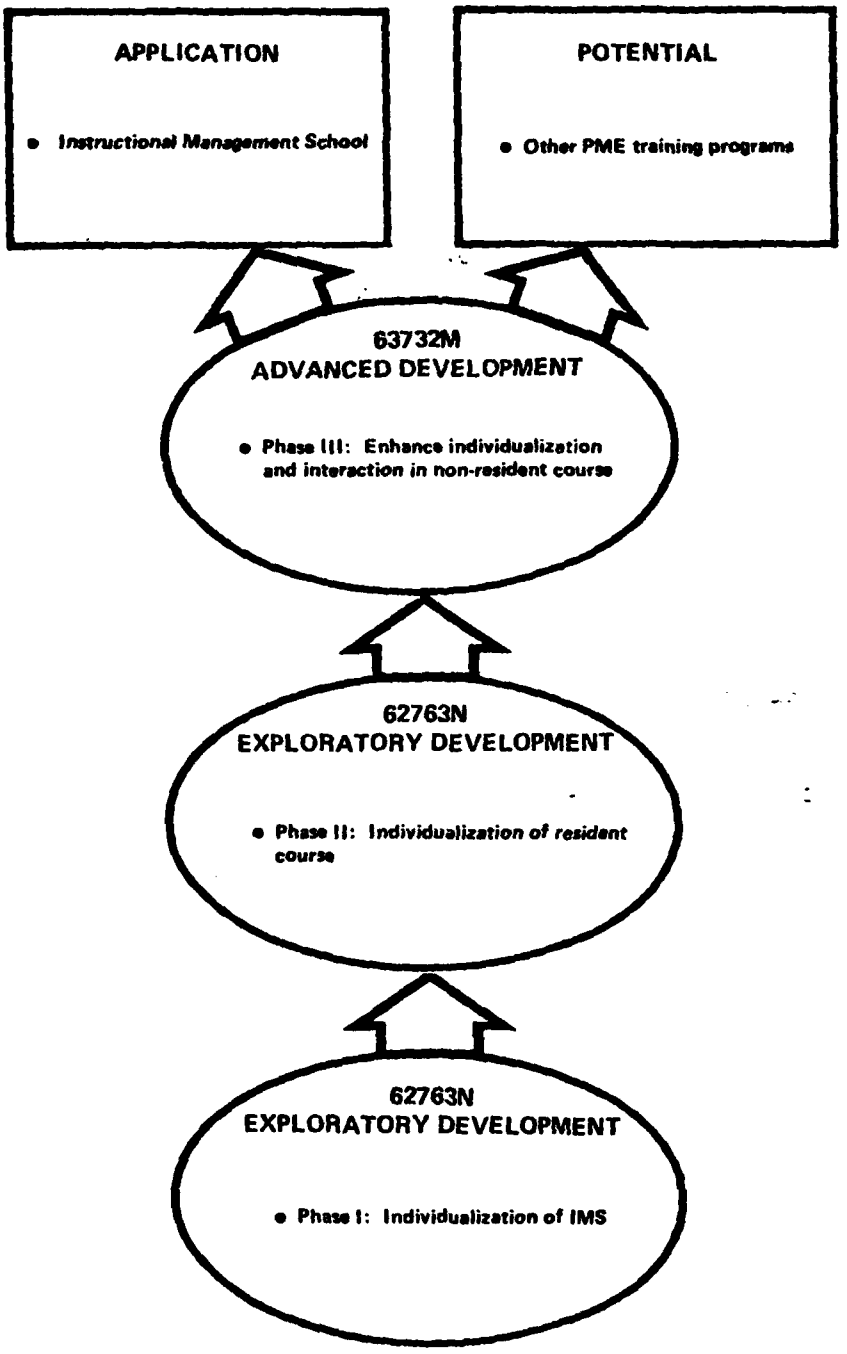
Program Element 63732M, Marine Corps Advanced Manpower/Training Systems, Project C1732-PN-01, USMC Professional Military Education. The responsible researcher is Dr. C. A. Robinson, Navy Personnel Research and Development Center (NAVPERSRANDCEN) (Code 52), (619) 225-7122. Contract support has been provided by Human Resources Research Organization, Carmel, California, 93923, with the principal investigators being Dr. S. N. Joyner and Dr. R. Vineberg. The work was initiated in FY80 and is continuing. Publications have included:

- NAVPERSRANDCEN Special Report (SR) 83-19, *Feasibility of Individualized Instruction for USMC Professional Military Education Program: Phase I—Implementation at Instructional Management School*, March 1983.
- NAVPERSRANDCEN SR 83-45, *Handbook for Individualized Instruction*, July 1983.

Additional information may be obtained from MATRIS using the following indexing vocabulary:

- Primary Terms:
  - 3.04.08 Individualized Instruction (Self-paced)
  - 3.02.27 Instructor Training
  - 3.15.05 Instructional Evaluation
- Secondary Terms:
  - 4.01.10 Instructor Role (Simulators, Individualized Instruction)
  - 4.02.20 Instructional Media Selection
  - 4.02.17 Instructional Design Handbooks
  - 4.02.14 Study/Training/Learning Strategies (Self-paced, Remedial)
  - 13.01.18 Officer Personnel
  - 13.01.17 Noncommissioned Officers (NCO's/Petty Officers)
  - 3.12.10 Professional Development/Education
  - 13.01.12 Marine Corps Personnel

Program dynamics are:



REMOTE SITES TRAINING USING MICROPROCESSORS

Need

In a combat situation, the Operations Specialist must be prepared for the likelihood that the targets he is detecting and tracking on his radar scope will be obscured, that is, that the scope will be "jammed" by an enemy who is using Electronic Countermeasures (ECM). The enemy who is using ECM is doing so to prevent detection of his platform, for example an aircraft or ship. Therefore, it is critical that the Operations Specialist recognize the type of ECM which is appearing on his scope and hiding the targets, and apply the appropriate Electronic Counter-countermeasure (ECCM) feature or "fix" to clear the scope and continue tracking the enemy platform. Sufficient combat training for skills such as these has been difficult to provide in peacetime because it has required expensive simulators, large computers capable of delivering computer-based instruction or large battle-group Fleet exercises utilizing actual equipment. As a result, much of the training is in the form of classroom lecture which, by itself, does not capture the dynamic properties of the representative combat skills.

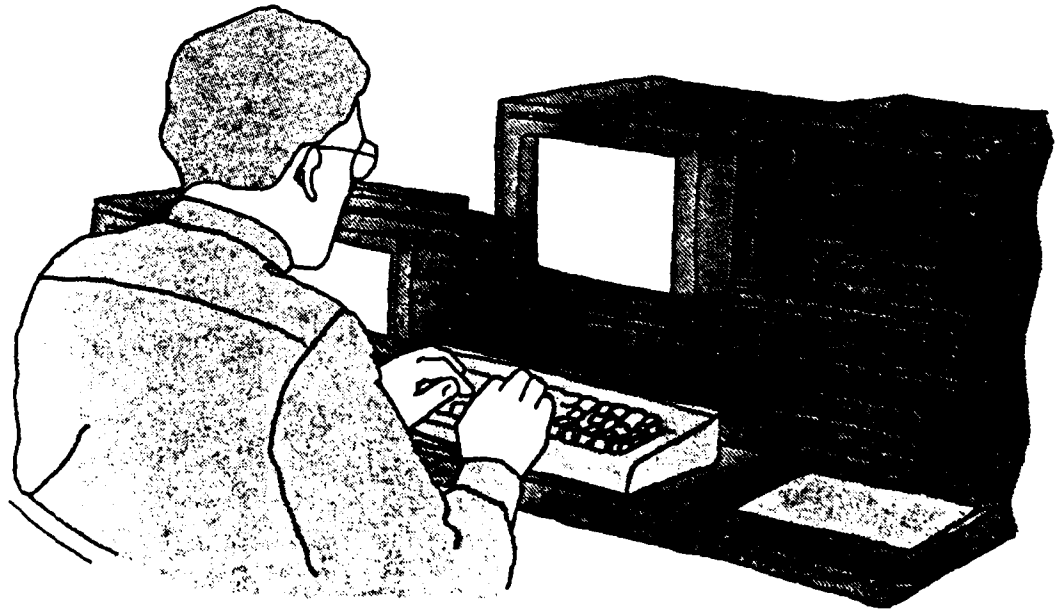
The problem of ECM/ECCM training was recognized by the Navy in 1972 and formally stated in a Training Analysis and Evaluation Group report in 1975. Naval exercises conducted at that time revealed that only 60 percent of the participating ships had prior exposure to ECM. It was determined, also, that the type of training that could be provided during Fleet Electronic Warfare Group exercises was so advanced that it did not benefit the inexperienced operators (40 percent) who most needed the training. As a result, the Chief of Naval Material initiated an ECCM improvement program. Studies conducted as part of this program estimated that 45 percent of the surface Navy ECCM problems were training related.

The Navy Personnel Research and Development Center (NAVPERSRANDCEN), under the direction of Commander, Training Command Pacific, recognized that a potential remedy to this training problem would be a method of training that could be used at school settings and also at remote sites such as ships and Fleet training groups. In this way, students could be given initial training at the schools and, because they would not receive regular on-the-job training in these skills, they could receive adequate refresher training at remote sites. The use of microprocessors appeared ideal for presenting this training because they are capable of providing a large amount of training and are portable.

Approach and Results

In order to test these ideas, a microprocessor-based system was configured which had the following features: two disk drives (one for presentation of instruction and one for collection of performance data), a CRT, a keyboard, and a software package that had graphics capabilities with high resolution. The system also incorporated a betamax videotape player, a television monitor, and a random access search unit for indexing specific portions of videotape in instruction. The purposes of this research project were to design and develop microprocessor-based ECM and ECCM training; refine the training at a Fleet school prior to remote site testing; evaluate the learning and cost efficiency of the training; and determine skill retention following the training in order to recommend optimal refresher training intervals.

In the first phase of this research project, initial ECM training was developed. This process involved the generous assistance of the personnel at the Fleet Combat Training Center; Pacific (FLECOMBATRACENPAC): as soon as initial



training was developed and equipment was purchased, the FLECOMBATRACENPAC personnel agreed to implement the training on an experimental basis. Data collection regarding the effectiveness of the training was begun immediately. In addition, the school personnel served as subject matter experts and provided countless hours of assistance in getting the training "correct." The students who served as subjects in the research also served as subject matter experts in the important aspect of "what the students like and will accept." The evaluation of this phase provided data on how much the students learned, how much they remembered and how well they liked it. Based on the results of this evaluation, a second phase was initiated in which the ECM training was modified and, in addition, ECCM training was developed. (The ECCM training will not be described in this report.) Again, the training was evaluated at the FLECOMBATRACENPAC and one system was put aboard the USS DAVID R. RAY (DD 971) for remote site test and evaluation.

The ECM training begins with a pretest of the student's ability to recognize videotaped examples of ECM. This pretest provides a baseline against which any further analyses of training efficiency will be compared. Following the pretest, the student receives instruction in ECM recognition accompanied by narrated videotapes and computer-based graphics which describe each type of ECM, how it can vary in appearance, why it looks the way it does, and how it is typically used in Electronic Warfare. When the student feels ready, the next step in training is Drill and Practice in which the student must identify ECM from videotapes and immediate feedback is given which tells the student whether or not he is correct and how long it took him to make the identification. Finally, the student takes a Performance test in which many new examples of ECM must be identified. There is no feedback until completion of the test. Throughout the training, the student receives progress reports indicating scores and response times for each aspect of the training.

The research and development part of this project has now been completed. Over 600 students have participated in the training. Analyses have shown the training to be extremely effective as well as enthusiastically received by students and instructors alike. Analyses have also shown dramatic increases in ECM recognition ability and a marked reduction in the amount of time it takes students to recognize ECM. Furthermore, NAVPERSRANDCEN has conducted tests to determine how much of this skill is retained over time and has found that from one to six months after training, there is no decrement in skill level. The next step in this project will be a full-scale implementation of the training at FLECOMBATRACENPAC, both Pacific and Atlantic, and at remote sites.

Utilization and Impact

The results of the research and development of this training shows that microprocessors can be successfully used to provide training for a skill that receives little practice in peacetime. Because of this finding, the ECM training that was actually developed and tested will be implemented Navy-wide. The results are also encouraging for other combat-related skills that receive inadequate training in peacetime. Microprocessors are excellent tools to supplement schoolhouse and on-the-job training; they can be used in initial and refresher training. They are inexpensive and portable and, as technology grows, become increasingly capable of providing sophisticated training, testing, and simulation.

Research and Development Notes

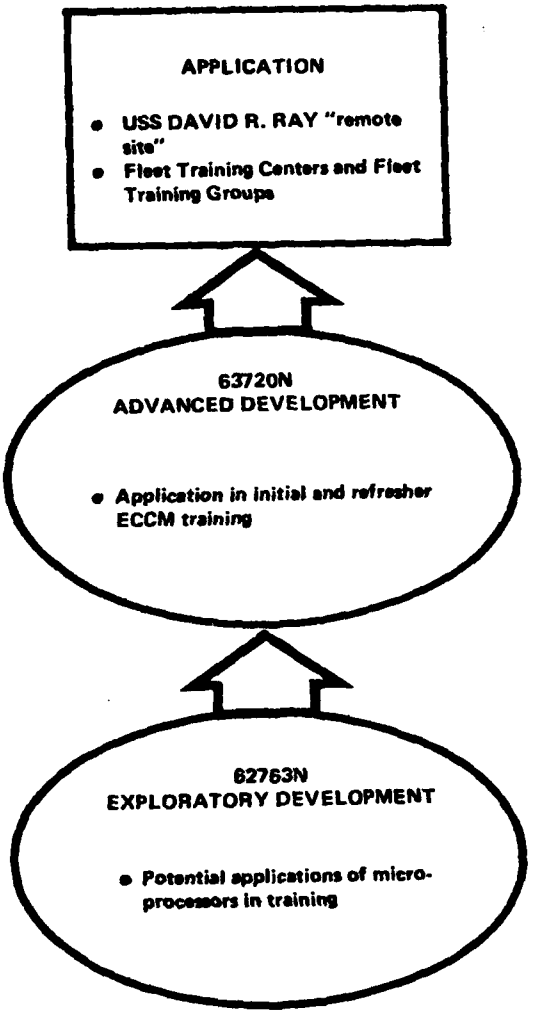
NAVPERSRANDCEN conducted this research beginning in FY79 and ending in FY84. It was sponsored by the Deputy Chief of Naval Operations (Manpower, Personnel and Training, (OP-01) and identified as Z1177-PN-01, Remote Sites Training Using Microprocessors, in Program Element 63720N, Education and Training. The principal investigator was Dr. Barbara McDonald, NAVPERSRANDCEN, (619) 225-6434. Relevant documents include:

- NAVPERSRANDCEN Technical Report (TR) 82-10, *Evaluation of Electronic Counter-Countermeasures Training Using Microcomputer Based Technology: Phase I Basic Jamming Recognition.*
- *Computer-Assisted Video Learning for Technical Training,* Society for Applied Technology, McDonald, B.A. and Crawford, A.M., August 1981.
- McDonald, B.A. and Crawford A.M., "Remote-Site Training Using Microprocessors," *Journal of Computer-Based Instruction,* Volume 10, Nos. 3 and 4, 1983.

Additional information can be obtained from MATRIS using the following indexing vocabulary:

- Primary Terms:
  - 3.08.26 Radar Trainer/Simulator (Digital)
  - 10.07.32 Countermeasures (Electronic, Optical, Visual)
  - 3.04.12 Computer-aided/Assisted Instruction (CAI)
- Secondary Terms:
  - 9.05.01 Target Tracking
  - 4.03.20 Microcomputers/Microprocessors/Programmable Calculators
  - 3.09.01 Training Tapes (Audio, Magnetic, Video)
  - 4.01.39 Skill Retention/Perishability
  - 3.15.03 Training Effectiveness Validation/Assessment
  - 4.04.04 Training Device Procurement/Acceptance (Criteria, LCSMM)
  - 3.03.01 School
  - 3.03.02 Remote Site (Shipboard)
  - 3.02.43 Refresher Training

Program dynamics are:



HUMAN FACTORS ENGINEERING

In the Department of Defense, human factors engineering is defined as the "Development of improved methods and technologies for the analysis, design, and evaluation of equipment and systems for safer and more efficient operation and maintenance."

The Navy needs equipment and support systems designed in such a way that people can do their job faster, more accurately, and more safely when they operate, maintain, or employ equipment. The Navy's research and development program in human factors engineering is involved in all systems, from their initial formulation to test and evaluation. The program develops procedures and technology that will be applied by practicing human factors engineering specialists in various development agencies and contractor firms.

Projects in this category include:

- **Robotics and Automation Research and Development Projects**
- **Human-Computer Interface For Dialogue Systems**
- **Voice-Interactive Systems for Navy Aircraft**
- **Real-Time Simulation For Testing Passive Anti-Submarine Warfare (ASW) Signal Processing Systems**
- **Forward-Looking Infrared (FLIR) Algorithms for Joint Munitions Effectiveness Manuals**
- **Operability Testing of Sonar System Designs**
- **Propulsion Plant Control**
- **Shipboard Damage Control Consoles**
- **Using Shipboard Collective Protection Systems to Control Fire-Generated Smoke and Toxic Gas**
- **Ship Distance Monitoring System For Underway Replenishment Operations**

ROBOTICS AND AUTOMATION RESEARCH AND DEVELOPMENT PROJECTS

Need

The Navy is faced with many manpower issues caused by the expansion to a 600-ship Fleet; the increased complexity of new ship systems; the existence of many tasks which are labor-intensive, mundane, or unsafe; and the demographic projections of reduced manpower availability for the future. These considerations emphasize the need to improve recruiting and retention through application of technologies such as robotics and automation. These applications can improve efficiency, quality and productivity and can reduce the number of mundane and unsafe tasks performed by Navy personnel. This will also result in increased morale and quality of life and better utilization of manpower.

In specific application areas, a Naval Sea Systems Command (NAVSEASYSCOM) and Naval Air Systems Command (NAVAIRSYSCOM) Flag Level Steering Committee identified the need for increased use of automation in aircraft carrier fire fighting, a NAVSEASYSCOM CONFORM study was initiated to identify needs for Navy robotics applications, and the Defense Nuclear Agency has established a program to investigate and implement robotics for security applications.

Approach

The Navy has recognized the need to establish and apply the rapidly expanding, multi-disciplinary robotics technology early in the research, development, procurement, and training processes in order to build the technology base and to coordinate and implement robotics in Navy-unique efforts. The NAVSEASYSCOM established an Assistant for Robots and Manufacturing Technology (SEA 90G) in 1983. The Naval Surface Weapons Center (NAVSURFWPNCEN) has responded to the critical need for research and development efforts in robotics by constructing the Navy's only laboratory dedicated to robotics.

The general approach to applying robotics and automation has been to:

- Identify specific Navy needs.
- Determine if the required technology exists in private industry or government.
- Maintain and expand the technology base within the Navy as needed.
- Develop and test modular subsystems and total systems.

Joint efforts between the Navy, industry, academia, and other government agencies have often been established to accomplish this approach.

Fleet surveys and visits to Fleet units collect inputs from Fleet users have been used to confirm initial requirements. Subsystems and sensors have been developed and there has been planning for utilization in robotic and automation systems. Specific examples include research in the areas of:

- Three-dimensional (3-D) passive vision to augment human vision in robotic hazardous applications.
- Infrared sensors to be used in firefighting.
- Magnetorestrictive materials to be applied as robotic tactile sensors.
- Mobility to allow application of robotics in unstructured Navy-unique environments such as those found in shipboard, sentry, and hazardous operations.

Utilization and Impact

The NAVSURFWPNCEN research in 3-D machine vision was extended to applications in the areas of mobile robots and welding and manufacturing operations. In each area, the abilities of the human operator will be extended or replaced in tedious or potentially unsafe environments through robotic applications.

The future thrusts for research are in the directions of advanced sensors, adaptive control, artificial intelligence, improved mobility subsystems, and greater strength-to-weight ratio capabilities. Developments in these areas will result in a higher level of intelligence for robotic systems in order to better supplement or replace human capabilities.

In many areas of research and development of robotic systems, the subsystem technology or products can be transferred to other government and industrial applications. Prime examples of this are the unique passive 3-D vision system which can be extended to other machine and computer vision applications for object identification, night vision, and collision or obstacle avoidance; and a mobile robot which would have many applications in warehouses, nuclear maintenance, and remote oil rigs.

Research and Development Notes

Responsible researchers for this effort at NAVSURFWPNCEN have been Dr. Thomas R. McKnight, Russell L. Werneth, and Mary A. Lacky, NAVSURFWPNCEN (Code E-06), (202) 394-3256, Autovon 290-3256. Project titles have included "Passive 3-D Vision for Robotics Applications" and, in Program Element 63514N, Shipboard Damage Control, Project S1565, Remote Controlled Fire Fighting Platform Prototype.

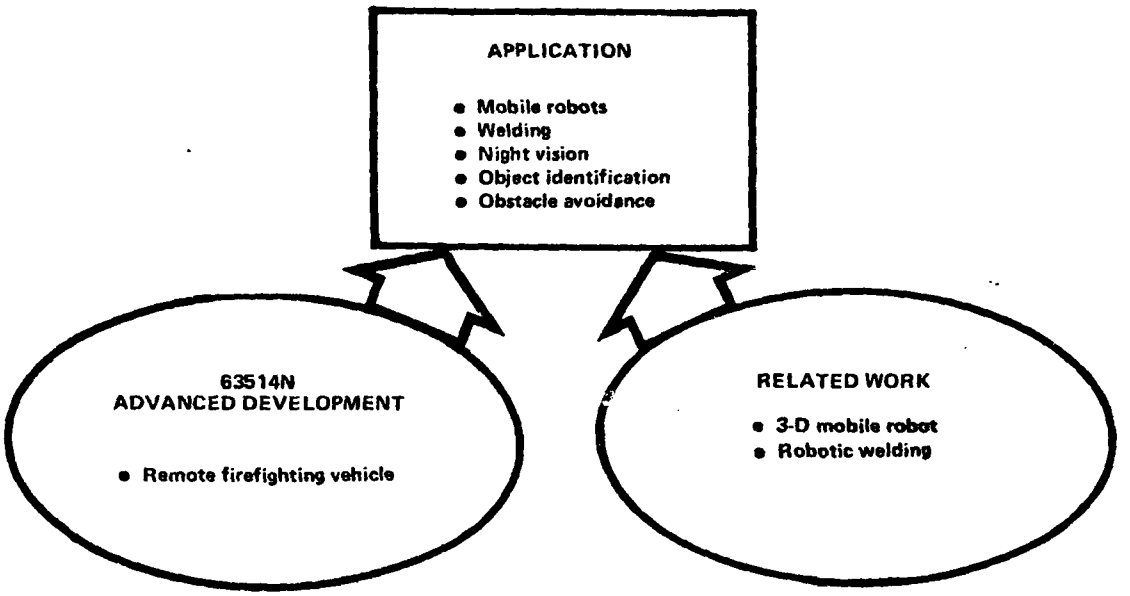
Additional information can be obtained from MATRIS using the following indexing vocabulary:

- Primary Terms:
  - 10.01.47 Robotic/Bionic Systems
  - 4.01.36 Artificial Intelligence Techniques (Expert Systems)

10.09.04 Automation Levels, HFE Design Analysis
9.09.07 Automation, Effects

- Secondary Terms:
  10.02.30 Displays, 3-D (Stereoscopic, Spacegraph)
  3.09.10 Fire-Fighting Training Simulation (Sensors)
  10.03.01 Control Systems, Adaptive Computer-Aided
  10.01.52 Sensor Systems (BETA)
  10.08.10 System Safety Design
  10.08.26 Human Operator Models/Simulators (HOS)

Program dynamics are:



HUMAN-COMPUTER INTERFACE FOR DIALOGUE SYSTEMS

Need

Real-time evaluation and analysis of information are common operational requirements for a large number of naval sensor, command, and weapon systems where an ever-increasing volume of data made available through advancing technology has created the potential for overload conditions in human-computer systems. Corollary problems include:

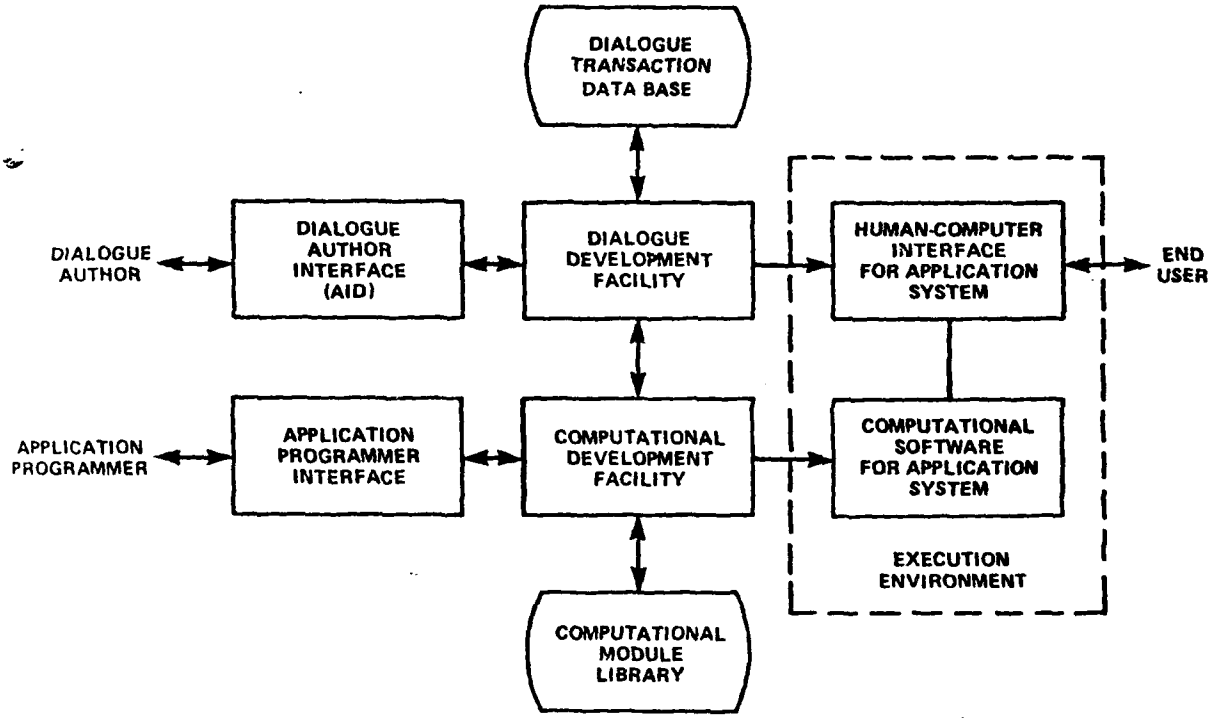
- Dealing with time-critical information.
- Finding the optimal organization for different mixes of information.
- Detecting errors or missing data.
- Providing the optimal organization for the diverse functions of alerting the user to critical events, monitoring multiple events, diagnosing problem conditions, and presenting alternate courses of action.
- Allocating appropriate tasks to computers, operators, and decision makers.

A fundamental step toward the correction of these problems is the proper design of human-computer system interfaces. A major reason for poor design of such interfaces has been the interleaving of the dialogue formats for input and output functions with the design of the computational software to drive those functions. The applications programmer who skillfully performs the latter task is usually less than adept at the choice and design of the display formats. A solution to this practice is to design tools for a dialogue author to create dialogue formats, design a separate set of tools for the applications programmer to implement those formats, and to incorporate a facility to merge these two products into an easily modified interface specification.

Approach and Results

The concept of independence of the dialogue formats from their computational software was realized in the development of a dialogue management system (DMS) which accepted inputs from keyboards, touch panels, and

voice systems and permitted the design and dialogues in text, graphics, and voice. The quality of the interface designs from the DMS was confirmed with demonstrations of human-computer systems for handling multi-attribute tasks under various conditions of task loading. Software tools for authoring the human-computer dialogue formats and for developing their computational software were designed and evaluated successfully. They included menu builders, graphic builders, text formatters, dialogue builders, design expert techniques, voice interaction builders, help formatters, and dialogue simulations. An illustration of the DMS is shown in the accompanying figure.



DIALOGUE MANAGEMENT SYSTEM

Utilization and Impact

The concept of a DMS, particularly for use in the speech input output mode, has been adopted by developers at Naval Surface Weapons Center, Dahlgren for use in surface ship operations. One industrial firm, Digital Equipment Corporation, has implemented the DMS in its developmental facilities for the design and evaluation of potential human-computer interface modes. Formal evaluations of the DMS need to be undertaken in realistic task settings; plans to perform experimental programs, as well as to improve the design of software tools, has commenced at Virginia Polytechnic Institute and State University (VPI&SU) under National Science Foundation funding.

Significant contributions have been made in three areas critical to the design of interfaces:

- Development of models and concepts of the components of human-computer dialogues.
- Design of software tools to support a DMS to serve the functions of authoring and executing dialogues and tailoring system output to the end user.
- Refinement and further extension of human factor principles to guide the design of input and output characteristics of human-computer interaction.

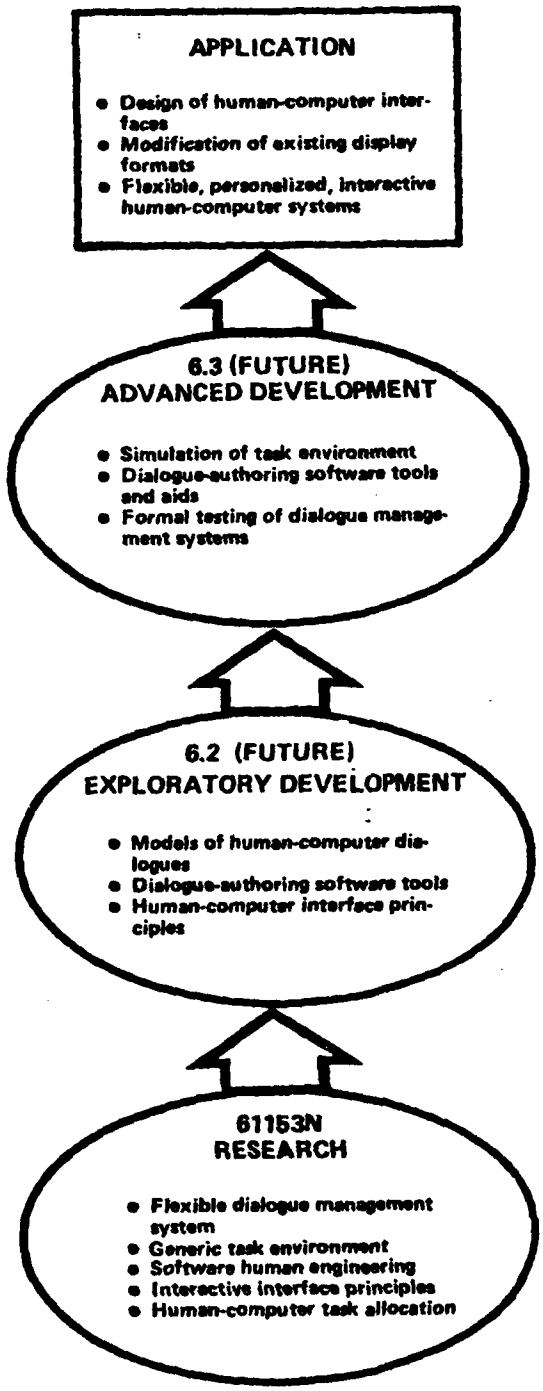
Research and Development Notes

This program was performed by VPI&SU under the sponsorship of the Chief of Naval Research (ONR). The principal investigators were Drs. R. C. Williges and R. H. Ehrlich. The project was funded in Program Element 61153N, Defense Research Sciences, Subelement 42, Behavioral and Social Sciences, Project RR042-09, Engineering Psychology. The responsible program monitor was Dr. J. J. O'Hare, ONR (Code 442EP), (202) 696-4502. The project was initiated in 1980 and was completed in 1984. The design of the DMS

is described in a Technical Report (TR) distributed in 1983, *The Role of a Dialogue Author in Creating Interfaces* (TR CSIE-82-8: AD A118146). Fifteen technical reports are available from the contractor on other aspects of the program and their results have been summarized in Williges, et al., *Human-computer interactions and decision behavior, Final report* (TR CSIE-83-16), Blacksburg, VA: VPI&SU, January 1984. Additional information can be obtained from MATRIS using the following indexing vocabulary:

- Primary Terms:
  - 10.08.34 Man-Computer Interface/Interaction (ERROR)
  - 10.01.26 Computer Systems (Interactive)
  - 10.08.23 Information Display Requirements
  - 10.06.12 Communication, Man-Computer (Natural Language)
- Secondary Terms:
  - 9.08.20 Decision Making, Information Requirements
  - 10.02.28 Display Design Parameters
  - 10.06.04 Voice/Speech Synthesis, Automated
  - 10.06.14 Voice/Speech Recognition (Automated)
  - 12.03.15 ADP Software Development
  - 4.02.28 Authoring Aids/Guidelines (Automated)

Program dynamics are:



VOICE-INTERACTIVE SYSTEMS FOR NAVY AIRCRAFT

Need

There exists a critical problem of excessive operator workload in modern airborne platforms such as the Navy F A-18, F-14 and P-3C (Update III) aircraft. The workload problem is a direct result of the increase in number and complexity of new avionic systems such as the Advance Signal Processor (i.e., Proteus System on P-3C Update III), the Head-Up-Display, multifunction controls and displays, and Communications Navigation Intercept (CNI) equipment, with all of these systems requiring the operator to produce manual and/or visual responses within restricted time frames. The critical outcome of this proliferation of tasking is an operator who produces unacceptable response times and error rates which directly impact mission success and crew safety.

Approach and Results

The objective of the Voice-Interactive Systems and Technology (VIST) effort is to resolve the problem of excessive visual and manual workload in naval air systems by developing a capability to transfer visual and motor operator tasks to the less saturated vocal and auditory input and output modes. This requires development of voice recognition, processing and synthesis technology for Navy airborne systems, and design of generalized methods to determine the applicability and effectiveness of a voice-interactive system in advanced crewstations.

The VIST exploratory development project addresses the following developments:

- Syntax processing software to improve performance and flexibility of voice-interactive systems.
- Voice synthesis technology.
- Analytical methods to determine suitability and specific functions for voice-interactive systems in existing and emerging aircraft crewstations.
- Limited continuous speech recognition (LCSR) technology.

Technology Base Advance

The technological issues are threefold:

- Development of voice recognition hardware and software for identification of human speech.
- Development of voice synthesis hardware and software for generation of human speech.
- Development of a methodology for evaluating crewstations for applicability and payoff of a voice recognition and synthesis system.

Voice recognition technology has progressed to the point that current systems can accurately recognize human speech even under specific types of environmental noise. Several manufacturers of this technology are currently producing voice recognition systems specifically for military airborne applications. Additional research is needed, however, on the noise stripping algorithms which are incorporated into the airborne voice recognizers in order for such systems to be effective in the aircraft noise environment. Further research in speech sysnthesis technology is required to determine how, within an aircraft system, synthesis can be optimally utilized with a voice recognition system. The final technology issue is the development of a methodology for determination of voice functions within a crewstation. Previous research has demonstrated the requirement and provided a preliminary methodology for determination of specific crewstation functions for voice control. Additional research is planned on refinement of the methodology along with applying and validating this methodology in the F/A-18 crewstation.

Impact

The VIST program is targeted to impact three Navy aircraft systems: P-3C (Update III), F-14A, and the F/A-18. Previous studies on the P-3C have demonstrated the need for voice-interactive technology specifically in the navigation and communication (NAVCOM) station and Sensor Stations 1 and 2 due to the excessive visual and motor requirements imposed on the operator. Incorporation of voice technology into the respective stations aboard the P-3C would have a significant impact on improving operator's performance by transferring excessive visual and motor tasks to the less saturated vocal and auditory channels. The VIST program will also impact the F-14A and F/A-18 platforms by reducing the number of secondary visual and motor tasks required of the operator, thus allowing the operator more time to concentrate on primary tasks such as target acquisition, weapons delivery and navigation. Preliminary analysis of the F-14A and F/A-18 aircrafts indicate several high payoff areas for utilization and voice technology:

- Up-Front Controller in the F/A-18 for voice control of the UHF/VHF radio channels, waypoint data entry for navigation, and check-list retrieval.
- Voice control in the F-14A of the AN/ARC-159 UHF radio and panel, checklist retrieval, and tactical information control panel (i.e., Radar Intercept Officer crewstation).

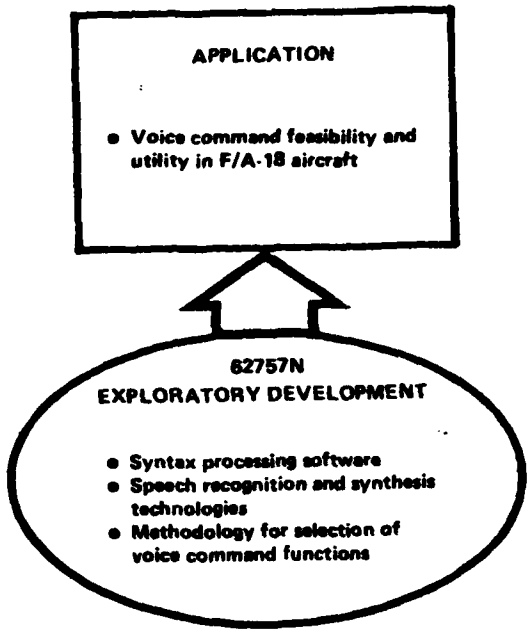
Research and Development Notes

This work has been performed in Program Element 62757N, Human Factors and Simulaton Technology commencing in FY82 and continuing. The project is identified as F57525. The Naval Air Systems Command (Code 370) sponsors the effort. The responsible researcher is Dr. Norman Warner, Naval Air Development Center (Code 6021), Warminster, Pennsylvania, 18974, (215) 441-2947.

Additional information is available from MATRIS using the following indexing vocabulary:

- Primary Terms:
  - 10.06.01 Voice Control, Interactive
  - 10.01.02 Airborne Systems
  - 10.11.09 Aircraft Control-Display Systems, Design Principles
- Secondary Terms:
  - 10.06.14 Voice/Speech Recognition (Automated)
  - 10.06.04 Voice/Speech Synthesis, Automated
  - 10.01.14 Crew Stations
  - 10.01.09 Operator Performance Functions Data
  - 10.06.08 Message/Speech Processing
  - 10.06.09 Control Language, Interactive
  - 10.06.12 Communication, Man-Computer (Natural Language)
  - 10.04.06 Voice-Activated Switching Systems

Program dynamics are:



REAL-TIME SIMULATION FOR TESTING PASSIVE ANTI-SUBMARINE WARFARE (ASW) SIGNAL PROCESSING SYSTEMS

In this issue of the report, there are two articles which deal with simulation facilities related to acoustic signals in the ASW context. One article, in the section on Training Devices, discusses an ASW Training Research Facility. The other, in the section on Human Factors Engineering, discusses a Real-Time Simulation for Testing ASW Signal Processing Systems. While there is clear commonality of subject and coordination between the projects, the differing objectives should be kept in mind because they impact upon and cause differences in the characteristics of work undertaken.

Need

The use of realistic acoustic signals to test present and proposed ASW signal processing systems is necessary to validate the systems and to identify required improvements. These systems are designed to accurately measure complex signal characteristics, classify the signals, and track and localize the source of the signals. Real test signals are difficult to obtain because real ocean experiments are costly and rely on cooperative signal sources. Further, recordings of real ocean experiments often contain unexplained events and artifacts which make it difficult to test and validate a complex ASW signal processing technique.

Approach and Results

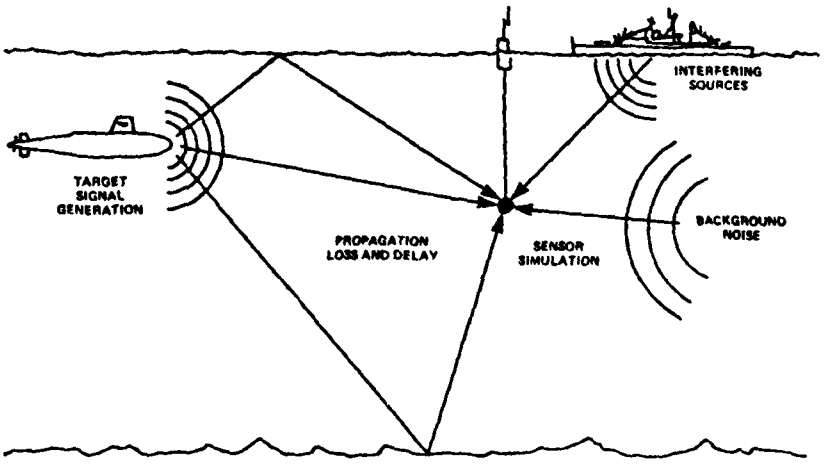
Since 1976, the Naval Surface Weapons Center (NAVSURFWPNCEN) has been providing realistic test signals for the evaluation of many of the signal processing systems now in the Fleet and also for systems still in various stages of development. NAVSURFWPNCEN provides realistic signals using an ASW Simulation Facility. The NAVSURFWPNCEN test materials are generated by a real-time acoustic simulator which produces signals which have the complex characteristics needed to test the advanced signal processing algorithms now in development. Three programs currently utilizing test materials are the Automated Detection and Computer Assisted Classification (AD/CAC) Validation Program, the Passive Tracking Algorithm (PTA) Program, and the Broadband Program. In the AD/CAC Validation Program, highly realistic target signals are mixed with real and simulated background noises at accurately known signal-to-noise ratios, for use in measuring system detection and classification performance. In the PTA Program, realistic target tracking scenarios are generated with precise knowledge of the target position to evaluate the accuracy of the tracking algorithm. In the Broadband Program, testing materials are generated with precise signal doppler and time delay, which is critical in evaluating new complex signal processing techniques.

The Simulation Facility has also been used to create training materials for use in the Deployable Acoustic Readiness Training System (DARTS) Program and the Operational Readiness Assessment and Training System (ORATS) Program. The DARTS Program uses simulated target signatures mixed with real background noise to provide proficiency training for acoustic operators using Naval Air Systems Command (NAVAIRSYSCOM) systems. This program supplements existing trainers and provides a quick response method for getting new material to the Fleet. The ORATS Program provides the same type materials for Naval Sea Systems Command (NAVSEASYSCOM) surface systems. In both of these programs the use of laboratory generated tapes presents a cost-effective method of providing highly realistic target signatures for proficiency training in an operational environment.

The NAVSURFWPNCEN Simulation Facility is composed of several simulation systems which produce real-time acoustic outputs. The outputs can be recorded on either analog or digital tape or played directly into an ASW signal processing system. The facility also has several advanced signal processing systems, such as the P3-C AN/AQA-7(V10) signal processor, to validate the simulation test materials. The actual simulation equipment consists of an AN/UYK-20 general purpose computer and an AN/UYS-1 signal processing computer, plus a variety of computer peripherals and special interfaces. The simulation system can be programmed directly in a stand-alone mode, or simulation problems can be developed on a VAX 11/780 computer which is also available at the facility. An entire set of simulation support software has been written for the VAX 11/780. This provides a convenient method for many persons to design and test complex simulation problems without operating the simulator and analyzing the results on a real signal processor. The support software provides signal building tools with which the user can create complex target signals using the Common Model Data Base format. The support software also includes design tools for background noise and ocean modeling, and diagnostic programs which analyze the targets and proposed simulation scenarios as they are designed.

Acoustic simulation requires treatment of several major components of underwater acoustics, as illustrated in the following figure. The actual capabilities of the Simulation Facility are:

- The simulator creates three high fidelity acoustic sources which can execute complex maneuvers within a 500-mile square gaming area.
- The acoustic sources have complex discrete frequencies and multiple broadband noises. The signal components can change with the target dynamics in real time as the exercise is running.
- The simulation includes up to eight directional passive sensors which can have independent dynamic geometry during a simulation.
- The simulation produces analog time domain signals which have the acoustic characteristics of the ASW sensors being simulated.
- The signals generated for each sensor have the appropriate aspect of dependence, doppler shift, propagation loss, and time delay. The received signals are coherent at all sensors within the gaming area and will support inter-sensor coherent signal processing.
- The simulation uses several different ocean models which can be tailored to specific applications. The ocean effects produced included shadow zones, convergence zones, surface ducts, and the normal direct, surface, and bottom bounce propagation paths. The propagation model produces up to six multipaths to simulate multipath effects realistically.
- Both simulated background noises and real background noises can be used with the simulated signals, to add more realism.
- The simulator runs in real time with direct operator control and/or with exact timed command control from digital tape which produces exact copies of simulation problems.



TOP LEVEL COMPONENTS OF ACOUSTIC SIMULATION

Utilization and Impact

The Simulation Facility is presently used full time to support the AD/CAC Validation and the DARTS and ORATS Programs. The simulation technology developed at NAVSURFWPNCEN is now available for use in other systems which require ASW acoustic simulation. NAVSURFWPNCEN is presently documenting all of its simulation technology to the form of a FORTRAN testbed on the VAX 11/780. The testbed is structured for the easy addition of new techniques and the display of any data transferred between any of the simulation software modules. This provides a convenient method for evaluating different techniques and documenting them at the same time. The testbed can also serve as a training device since many types of the displays can be generated in real time. The newly operational Passive Tracking Algorithm has been driven with a version of the testbed, providing results that agree well with real world data.

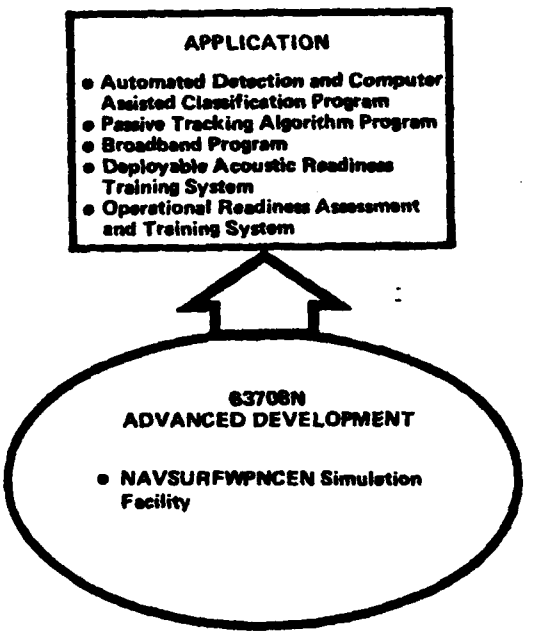
The simulation materials produced by NAVSURFWPNCEN have resulted in the accurate testing of AD/CAC algorithms and the transfer of AD/CAC technology between ASW platforms. Many of the ASW signal processing algorithms developed during the last decade have also used simulated signals generated at the NAVSURFWPNCEN Simulation Facility.

Research and Development Notes

The Simulation Facility is located at the Naval Surface Weapons Center, Silver Springs, Maryland, 20910. The simulation effort is a continuation of a real time acoustic simulation project started by the Manager, Anti-Submarine Warfare Systems Project Office (MASWSPO) in 1970. Funding is provided through Program Element 63708N, Anti-Submarine Warfare Signal Processing, and through various programs such as DARTS and ORATS that utilize acoustic tapes produced in the Simulation Facility. The project is directed by Mr. Dennis Stutzel, Project Manager, NAVSURFWPNCEN (Code U22), (202) 394-1729 and Mr. Philip J. Craun, Design Engineer (Code U22), (202) 394-2275. Additional information is available from MATRIS using the following indexing vocabulary:

- Primary Terms:
  - 3.09.22 Target Simulation Devices (Surface, Submarine)
  - 3.08.15 Sonar Acoustic Warfare Training Systems, Generalized
  - 9.05.01 Target Tracking
  - 9.04.01 Auditory Signal Classification (Acoustic Transients)
- Secondary Terms:
  - 9.07.09 Information Processing Factors (Signal-to-Noise Ratio)
  - 4.01.44 Training Realism (OPFOR)
  - 9.04.07 Auditory Performance, Test/Measurement
  - 3.08.20 Sonar Target Simulation Vehicle
  - 10.15.09 Target Identification/Classification (Thermal Imagery)
  - 9.02.02 Real-Time Measurement Devices
  - 10.01.19 Acoustic Warfare Systems
  - 3.07.01 Oceanographic/Geophysical Sensor Simulation
  - 4.02.06 Sonar Acoustic Warfare Parameters Models
  - 4.03.03 Simulation Fidelity (High/Low Image Generation, Cost)

Program dynamics are:



FORWARD-LOOKING INFRARED (FLIR) ALGORITHMS FOR JOINT MUNITIONS EFFECTIVENESS MANUALS

Need

All the offices of the Department of Defense which plan and execute tactical missions make use of the Joint Munitions Effectiveness Manuals (JMEMs) in planning missions and evaluating new or modified tactics. A JMEM for visual target acquisition and attack by tactical aircraft is being widely used.

The work on visual targeting for the JMEM has been directed by the Joint Technical Coordinating Group for Munitions Effectiveness (JTCG/ME), headed by the U.S.

Army Material Systems Analysis Activity at Aberdeen Proving Ground. A continuing tri-service organization, the Target Acquisition Working Group (TAWG), has provided the detailed technical direction and effort for the development of a launch opportunity algorithm (LOA) for visual targeting.

Forward-looking infrared (FLIR) sensors are now appearing in the inventories of all the services, with the potential for tactical operations at night or in atmospheric conditions which would not permit visual operations. The need exists for an addition to the JMEM to accommodate FLIR operations as part of the planning process.

The JTCG has recognized the need for an extension of the effort on FLIR, and has directed the TAWG to work in that field in addition to the continuing effort on visual targeting. The current effort on FLIR algorithms for inclusion in the JMEM will provide an operationally useful product.

Approach and Result

The development of a set of LOAs for FLIR (or LOA/FLIR) was initiated by interviews with experienced FLIR users. A structured questionnaire was administered individually to ten Navy and six Air Force personnel who had substantial flying experience with FLIR in training missions against land and sea targets. The results provided a list of characteristics which must be represented in a FLIR algorithm if it is to be responsive to user needs.

The second step was a critical review of the visual LOA, to determine what elements were usable for FLIR/LOA. The accompanying figure shows that most of the first part, involving flight trajectory, terrain masking and other geometric effects were used with only minor changes, while the latter elements, which involve the target signature and the FLIR system itself, are new.

The third step was the preparation of detailed flowcharts, equations and look-up tables necessary for the programming of the LOA/FLIR. This step has been completed and is being documented in two technical memoranda at the Naval Weapons Center.

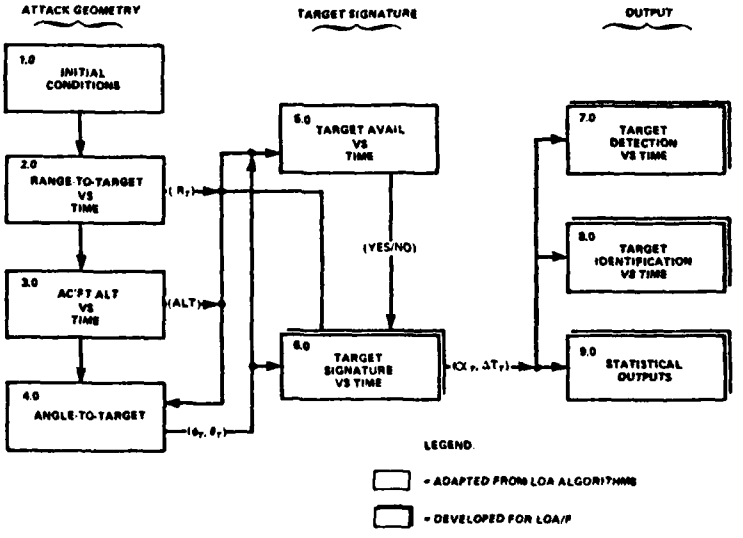
The next step will be programming the LOA/FLIR so that it can be thoroughly checked against available data and used in the preparation of a new section of the Visual Acquisition JMEM.

The features which distinguish the LOA/FLIR from existing FLIR models are:

- Incorporation of realistically complex and variable flight trajectories. The use of angle-off approach, low altitudes with pop-up, and standoff weapon launch are all accommodated.
- Provision for realistically variable terrain and weather conditions. Most models use one or more fixed mask angles and a "typical" set of weather parameters (e.g., "mid-latitude, summer, standard clear day"). The LOA/FLIR can provide answers up to significant (for planning) questions such as "pop-up altitude required for 90 percent probability of clear line-of-sight" or "probability of detection at 5 nmi range, in northern Europe, night, October."

Utilization and Impact

Experience with the visual LOA indicates that the JMEM is widely used by planning and tactics groups in the Department of Defense. A request for this extended LOA/FLIR capability was made by the JTCG/ME, indicating tri-service utilization when the final product becomes available. The programming of the LOA/FLIR is planned to be completed in FY85.



LAUNCH OPPORTUNITY ALGORITHM/FLIR – TOP-LEVEL FLOW

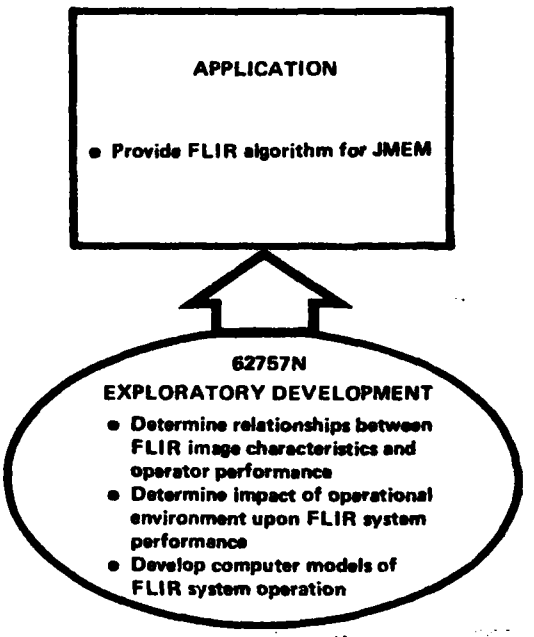
Improved utilization of expensive resources (FLIR-equipped aircraft) will result because the updated JMEM will permit more effective planning of missions under widely varying conditions. Aborted missions and missed objectives will both be reduced with improved prediction of FLIR-operable conditions.

Research and Development Notes

The performing agency for this effort has been the Targeting Division, Code 315, of the Naval Weapons Center, China Lake, California. Responsible individuals were R. A. Erikson (Code 31504), of the Targeting Analysis Office (and chairman of the TAWG), and Dr. C. P. Greening (Code 3152) of the Human Factors Branch. Funding was provided by the JTCG/ME. Two technical memoranda are in preparation, documenting progress to date on this effort. Additional information is available from MATRIS using the following indexing vocabulary:

- Primary Terms:
  - 10.01.52 Sensor Systems (BETA)
  - 10.01.45 Night Vision Systems
  - 10.15.10 Target Acquisition
  - 10.15.01 Mission Planning/Preparation
- Secondary Terms:
  - 3.09.09 Electro-Optical Sensor Simulators (FLIR, LLLTV, RADAR)
  - 3.08.23 Air-to-Ground Sensor Simulator (FLIR)
  - 10.07.35 Night Operations
  - 10.08.33 Image Processing Techniques/Algorithms
  - 9.03.02 Visual Search, Detection, Acquisition, and Identification
  - 5.05.08 Tactical Warfare Performance Measurement
  - 12.05.08 Guides/Handbooks/Manuals/Books
  - 12.05.04 Joint Service Development/Utilization

Program dynamics are:



OPERABILITY TESTING OF SONAR SYSTEM DESIGNS

Need

Advanced surface ship sonars are expected to significantly improve battle group capabilities. However, planned innovations in hardware, software, and man-machine interactions raise concern that the system may make excessive demands on its operators and seriously degrade performance, especially under conditions of high track load. Therefore, during design an operability test was needed for the investigation of these human factors implications.

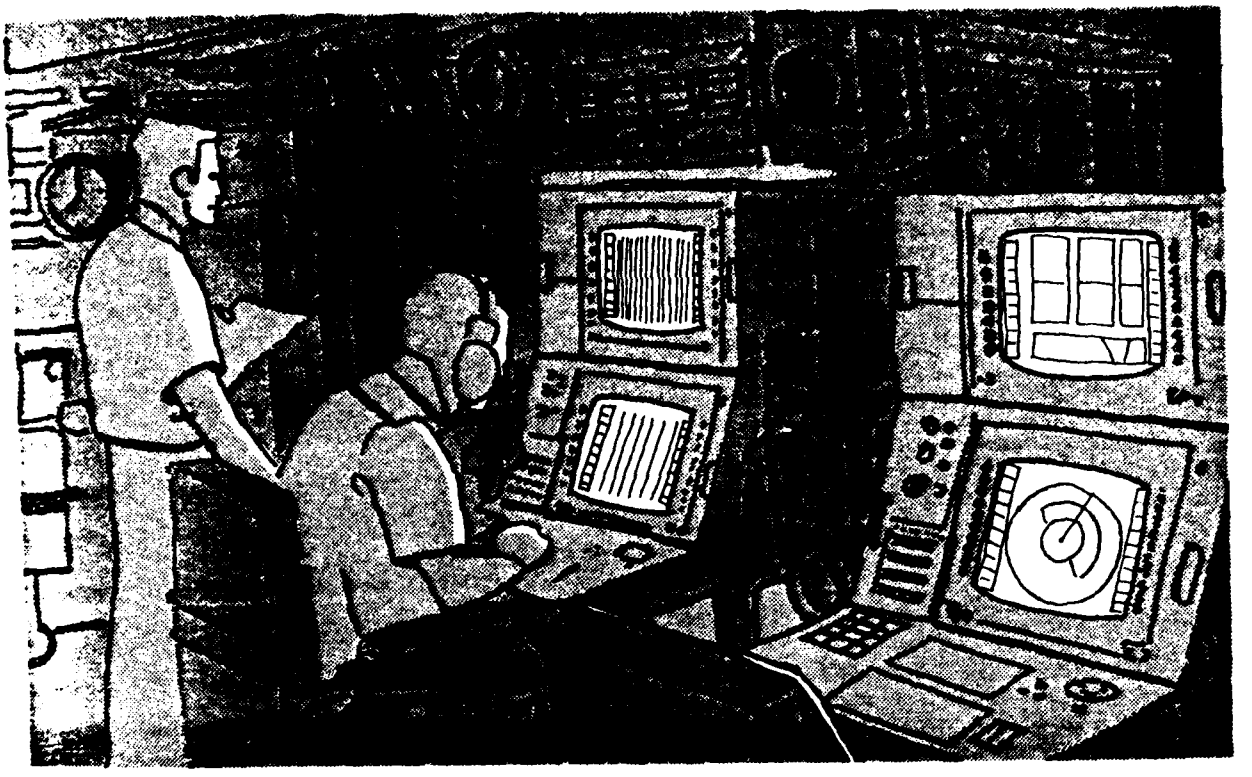
Approach and Results

In response to this need, the Naval Sea Systems Command (NAVSEASYSCOM) (PMS-411) and the Naval Underwater Systems Center (NUSC), New London, Connecticut, sponsored a task to conduct an operability test, evaluating display formats and operating procedures.

The initial thrust focused on evaluating active display formats proposed for the AN/SQS-53C sonar. An interactive simulation of the operator interface was developed and performance data were gathered from experienced Sonar Technicians using the simulation in representative scenarios. Specific system design recommendations for improving the operator interface were then provided.

The simulation was implemented on a desktop computer with high performance graphics. Display formats and available operator interactions approximated those of the AN/SQS-53C design. Test scenarios were administered over a three-day period and included valid contacts detected by the system, manual tracks that required detection and tracking by the operator, and false contacts. Briefly, the task for the operator was to monitor and interact with the search displays, manage the resources of the track receivers, and evaluate and classify all contacts. Surface Sonar Technicians at the Fleet Anti-Submarine Warfare Training Center, Pacific served as test personnel.

The simulation results indicated that the layout, symbology, interfaces, and procedures for the proposed display formats yield generally acceptable man-machine interactions. However, specific design recommendations were



SONAR SYSTEM DISPLAYS

...ge that may reduce operator errors by approximately ... percent.

The AN/SQS-53C design was found to facilitate joint ... solving by the system and a skilled operator. ... however, successful implementation of this concept requires ... appropriate training and depends critically on the quality of ... processor. Operators must appreciate that the automatic ... of the system are an aid and not a replacement ... and manual operations. Training simulators should ... a variety of false contacts and system errors.

Utilization and Impact

The results of this operability test have been presented ... SEASYSCOM (PMS-411), (SEA 63Y1), NUSC, and ... Electric. Several of the recommendations from ... have been incorporated in the system design ... tion.

The results also will be used in Advanced (6.3) Develop... which will extend operability testing to more realistic ... and with a more complete set of system func... the concepts and design approaches for display ... with advanced sonar systems; and analyze ... distribution and information flow in the sonar ... particular emphasis on the sonar supervisor.

... were to have been deployed with unsolved ... problems, substantial and recurring costs would ... correct them via system modifications, additional training, or increased manning. By conducting this operability test prior to full scale development, potential problems were identified early and corrected at minimal cost.

The methodology employed offers a low cost technique for assessing system operability and for providing design recommendations based on quantitative data. This study was performed for approximately 40 percent of the cost of one using more traditional methods to test the system displays.

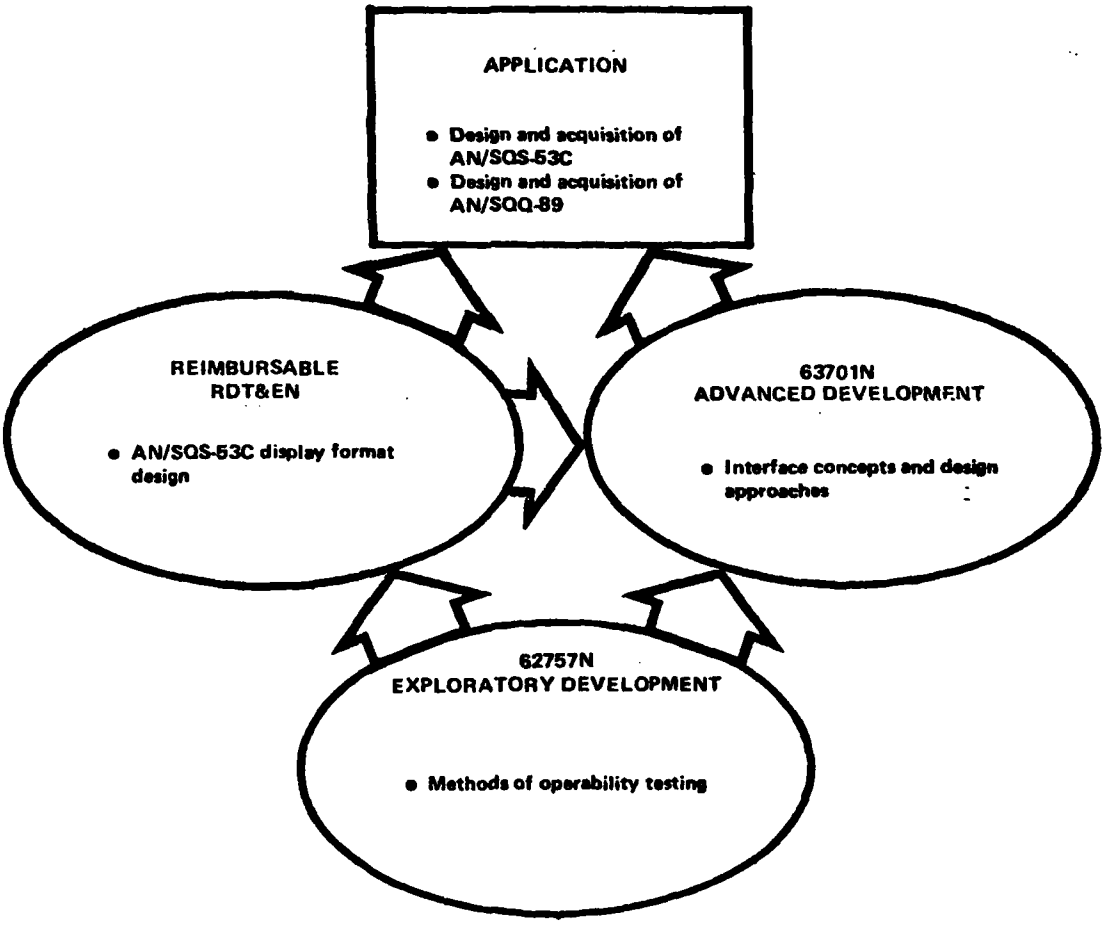
Research and Development Notes

This project was performed by the Navy Personnel Research and Development Center (NAVPERSANDCEN), San Diego, California, under Program Element 64575N, AN/SQS-53C, Project S1337-85 with reimbursable funding from NUSC, New London. The methodology was developed under an Exploratory Development task, SF57-525, Human Factors in Surface Ships, sponsored by NAVSEASYSCOM (SEA 61R2), in Program Element 62757N, Human Factors and Simulation Technology. The responsible researchers were R. L. Hershman and Dr. R. T. Kelly, NAVPERSANDCEN (Code 71), (619) 225-2081. The results of this study are discussed in detail in NAVPERSRANDCEN TR 84-27, *Operability Test of AN/SQS-53C, Active Sonar Displays,* February 1984 (Distribution limited to U.S. Government Agencies only). Additional information may

be obtained from MATRIS using the following indexing vocabulary:

- Primary Terms:
  - 10.08.05 Man-Machine System Design/Development
  - 10.08.24 Display Organization and Layout (Visual)
  - 3.07.08 ASW Simulation (Adaptive Maneuvering Logic)
  - 10.08.34 Man-Computer Interface/Interaction (Error)
- Secondary Terms:
  - 10.02.35 Displays, Graphic
  - 3.08.27 Anti-Submarine Warfare (ASW) Trainers (Tactical)
  - 10.08.01 Human Performance Modeling/Prediction (Reliability)
  - 10.08.04 Man-Machine Capability Models
  - 10.02.02 Displays, Interactive (Sonar)
  - 9.02.17 Operator Performance Recording/Evaluation
  - 10.08.23 Information Display Requirements
  - 10.08.08 Man-Machine Design Effectiveness

Program dynamics are:



PROPULSION PLANT CONTROL

Need

Serious problems exist in the operation of ship propulsion systems. Boiler explosions, inability of ships to meet underway schedules, and frequent failure of ships to pass operational propulsion plant examinations (OPPEs), give evidence of these problems. Investigations have determined that these problems result primarily from the inability of operating personnel to perform their duties adequately. Factors contributing to poor personnel performance include excessive complexity of plant operations, deficiencies in human engineering of plant equipment, and inefficient plant operating procedures. As a result, disproportionately high skills are required of plant operators. Since such skilled personnel are not readily available, propulsion plant failures continue.

The objective of this project is to develop and test methods for reducing the skill levels required in the operation of ship propulsion systems. By reducing the skill levels, a better match can be achieved between plant equipment and the capabilities of operating personnel. The methods developed during the course of this project will be applicable to new ship propulsion systems.

Approach and Results

To gain an understanding of problems in the Fleet before initiating the development of new design methods, an investigation was undertaken to verify the existence of propulsion plant operating problems and to identify ways of alleviating them. The intent was not to catalog obvious problems but to determine causes and to identify corrective actions that should be taken, particularly in the design of new ships. Deficiencies in the operating characteristics and procedures of 1200 psi steam propulsion plant aboard a pilot FF 1052 Class ship were identified. These included controls located beyond the reach of the operator, poorly designed gauges, and operating procedures that increase the workload beyond what is necessary.

In gas turbine plants, the central propulsion control console and associated operating procedures for the DD 963 Class of ships were evaluated. Deficiencies found in the console included difficulty in obtaining information from the computer and the inefficient arrangement of controls and displays.

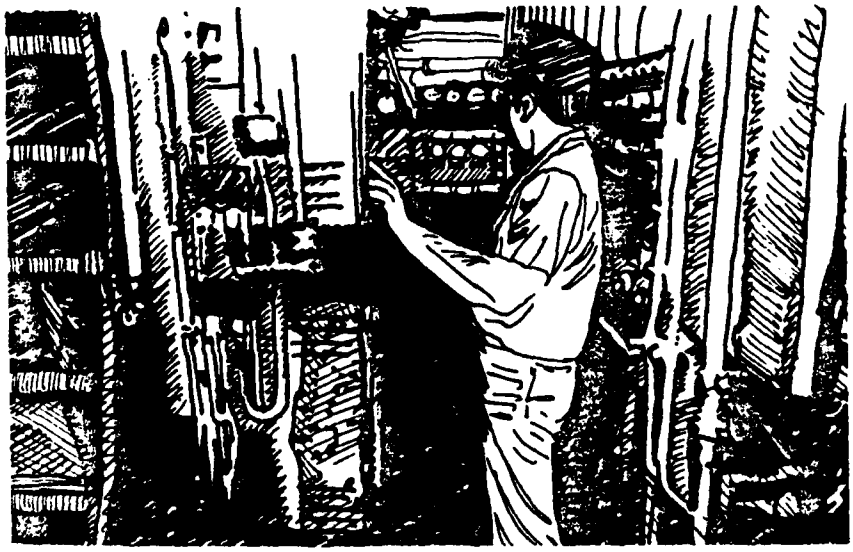
During FY83 and FY84, the findings of these investigations are being used to develop improved man-machine interface techniques for application to new construction plant design. Emphasis is being placed on:

- Improved handling of system operation.
- Control of malfunction at central control consoles.
- Improving interaction with personnel in areas remote from control spaces, using computers and modern display and control technologies.

Utilization and Impact

Improved man-machine interface techniques developed under this program have been applied in developing contractor guidance for design of the shaft control unit, main propulsion control, electric plant control, and damage control consoles for the CG 62 and DDG 51 Class ships, which are presently under development.

Findings of this research effort have resulted in increased emphasis being given to the use of computerized control of propulsion plant operations and to the display of plant status and malfunctions on large plasma displays. Additional future impact is anticipated in the area of propulsion plant and auxiliary equipment damage control system design.



Research and Development Notes

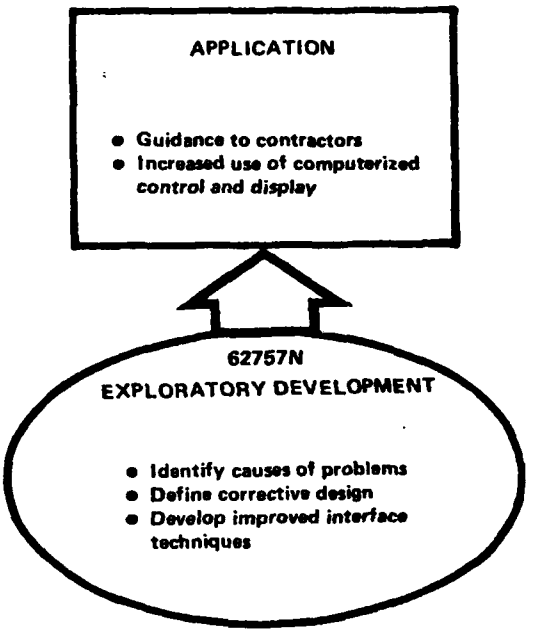
This research was sponsored by Code 61R of the Naval Sea Systems Command (NAVSEASYSCOM), beginning in FY81, as Exploratory (6.2) Development in Program Element 62757N, Human Factors and Simulation Technology, Project F57-525, Human Factors in Surface Ships, Task SF57-525-601-025, HFE in Propulsion Engineering. The principal investigator was Mr. H. L. Williams, Navy Personnel Research and Development Center (NAVPERSRANDCEN) (Code 71), (619) 225-6617. Relevant documents include:

- NAVPERSRANDCEN Special Report (SR) 82-25, *Problems in Operating the 1200 Psi Steam Propulsion Plant, An Investigation*, May 1982.
- NAVPERSRANDCEN SR 84-4, *Human Engineering Evaluation of the DD 963 Class Central Propulsion and Auxiliary Control Console (PACC), Implications for the Design of New Propulsion Systems*, October 1983.
- NAVPERSRANDCEN Technical Report (TR) 84-1, *Detection and Response to Malfunction in Gas Turbine Propulsion Systems*, October 1983.

Additional information may be obtained from MATRIS using the following indexing vocabulary:

- Primary Terms:
  - 10.01.34 Propulsion Systems (STEAMER)
  - 10.01.03 Surface Ship Systems
  - 8.02.25 Skill Reduction
  - 10.03.05 Control Innovations, Advanced
- Secondary Terms:
  - 10.08.05 Man-Machine System Design/Development
  - 10.03.10 Human Operator Control Models
  - 10.13.02 HFE in System Design, Application Methods
  - 10.08.08 Man-Machine Design Effectiveness
  - 10.11.01 Controls-Displays Design Principles, General
  - 10.03.01 Control Systems, Adaptive Computer-Aided
  - 12.03.02 Status Reporting (Control Techniques, Formats)
  - 13.02.21 Operators (Radar, Sonar, Switchboard)

Program dynamics are:



SHIPBOARD DAMAGE CONTROL CONSOLES

Need

The control of damage in battle (as well as in other circumstances) is critical to maintenance of fighting capability if not the very survivial of the ship. An essential ingredient in damage control is timely collection, interpretation, and distribution of information. Damage control consoles serve as focal points for this activity. However, the damage-inducing capabilities of modern weapons, and the speed with which an adversary could deploy them, are such that the information-handling capabilities of current damage control consoles are overloaded.

Further, current consoles lack the capability to support damage control adequately in a Chemical, Biological and Radiological (CBR) environment, which severly constrains and significantly alters conventional procedures. Enhanced capabilities are required in the consoles upon which personnel in damage control and repair lockers depend for information and for command and control.

Approach and Results

There are two major objectives in the development plan. One objective is to provide a "second generation" console for installation in existing ships. Another objective is to provide a "third generation" console for new construction ships.

The development of the second generation console will be accomplished by integrating, constructing and evaluating an improved-capability console for limited, collectively-protected ships, as an interim measure. Improved capabilities include active smoke removal and ventilation control, interface with the NAVSSES fire detector system, and inclusion of the MIT flooding and stability software module with the LHA ballast and flooding control capability. Feasibility of including the infrared imaging camera (for built-in applications) and utilization of a hand-held damage control data and symbology transmitting device will also be assessed. Also the inclusion of a designated, high-capability, secondary damage control station console will be investigated. The initial step will be to conceptualize and specify, in FY85, the integration of these capabilities into an existing FFG 7 Class-type console. Then a prototype console will be constructed and demonstrated in FY86, for procurement in FY87.

For the third generation console, development models addressing a host of ship crisis needs will be constructed. The eventual third generation console containing monitoring and control functions for collectively protected ships will have extensive functional flexibility features, such as:

- New technology displays and controls.
- Decision aiding, for single and multiple events.
- Embedded training.
- Advanced features from the second generation console development.

Utilization and Impact

These new consoles will aid ships' personnel in coping with casualties in a timely manner by addressing console capabilities, called out in the Chief of Naval Operations' *Summary Report on Lessons of the Falklands,* February 1983, and the National Research Council's Naval Studies Board 1982 study, *Implications of Advancing Technology for Naval Applications.*

Research and Development Notes

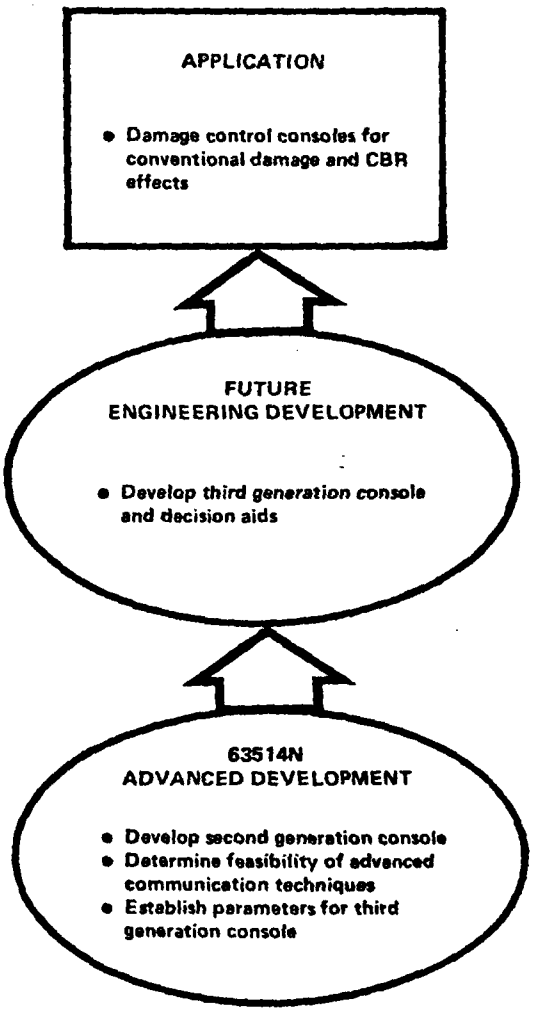
This work is funded in Program Element 63514N, Shipboard Damage Control, as Project S1565-SL. It is sponsored by the Naval Sea Systems Command (NAVSEASYSCOM). The David Taylor Naval Ship Research and Development Center (DTNAVSHIPRANDCEN), Annapolis, Maryland, 21402, is the performing activity. The responsible researcher is William R. McWhirter (Code 2731), (301) 267-2162, Autovon 281-2162. Reports issued to date are:

- DTNAVSHIPRANDCEN Technical Memorandum (TM) 27-83-95, *Some Technical Parameters to be Considered in the Design of a New Damage Control Console,* February 1984.
- Naval Ocean Systems Center Technical Note 1288, *C³ Issues, Concepts and Requirements for Shipboard Damage Control,* October 1983.

Additional information may be obtained from MATRIS using the following indexing vocabulary:

- Primary Terms:
  - 10.15.17 Damage Assessment
  - 10.05.03 Malfunction Display Systems
  - 10.06.05 Communications, Internal (Aircraft, Ship)
  - 10.08.05 Man-Machine System Design/Development
- Secondary Terms:
  - 5.02.10 Shipboard
  - 10.08.10 Systems Safety Design
  - 10.07.39 Chemical Warfare Factors
  - 9.08.07 Decision Making, Crisis Conditions
  - 3.04.20 Embedded Training

Program dynamics are:



USING SHIPBOARD COLLECTIVE PROTECTION SYSTEMS TO CONTROL FIRE-GENERATED SMOKE AND TOXIC GAS

Need

The Navy is developing systems for protection against Chemical, Biological and Radiological (CBR) warfare agents. A key element of CBR Defense is a shipboard Collective Protection System (CPS) which serves two purposes. The first purpose is to filter shipboard air through a series of carbon and High Efficiency Particulate Air (HEPA) filters to trap, contain and remove any chemical or biological agents. Secondly, the CPS is designed to maintain a positive air pressure in the protected compartments so that any air leakage would flow from the clean interior spaces to the contaminated outside environment.

While the primary function of the CPS on board Navy ships is to protect personnel and ships from chemical, biological and radiological attack, it is feasible to design the CPS so that it could also selectively function as a smoke control and removal system in the event of a shipboard fire. This added function would complement naval shipboard fire and smoke detection and firefighting systems rather than replace these systems. With this added smoke control and removal capability, the CPS could serve a vital peacetime function as well as its primary purpose of removing chemical, biological and radiological agents during times of hostility.

Approach and Results

In February 1982, a series of preliminary tests was conducted by the David Taylor Naval Ship Research and Development Center (DTNAVSHIPRANDCEN) at the U.S. Coast Guard (USCG) Fire and Safety Test Detachment at Mobile, Alabama. The tests were to determine the effectiveness of using an air supply fan operated in reverse to control the spread of and remove fire-induced smoke and toxic gases from a fire compartment and the adjoining passageway. During June 1983, a series of full-scale Class A fire tests was conducted in a simulated stateroom and laundry room. Tests have yielded several important findings:

- The present Navy doctrine requiring the securing of all ventilation systems upon detection of a fire produces the following baseline condition: in a stateroom or laundry room fire, visibility in the adjoining passageway is likely to be at least 50 percent obscured within approximately ten minutes.
- Utilizing the existing exhaust fan is extremely effective in controlling smoke and toxic gases generated in laundry room fires. During all laundry room fire tests with the exhaust fan restarted, visibility in the adjoining passageway was maintained at 95 percent for the duration of each test (30 minutes).
- For fires in staterooms, reversing the air supply fan will minimize smoke build-up in the adjoining passageway provided that the supply air system is coupled to the fan coil unit. Visibility in the passageway during these tests was maintained at 90 percent for the duration of the test (30 minutes).
- Rapid detection of shipboard fires (i.e., within three minutes of ignition) is critical to the success of smoke control and toxic gas removal through the use of the ventilation/CPS system. Failure to detect the fire rapidly allows the smoke buildup to become too heavy for the ventilation/CPS system to exhaust.

The next step in the development of a shipboard smoke control capability is a series of tests to be performed during the fourth quarter of FY84 to determine whether CPS overpressure can be maintained while controlling smoke generated during a fire; i.e., ships should be able to fight fires while maintaining CPS overpressure. A three-level pressurized zone mockup is being constructed aboard the test vessel SS ALBERT E. WATTS at the USCG Fire and Safety Test Detachment. The objective will be to control and exhaust smoke from fires on the middle level while maintaining overpressure on the other levels. A successful result would significantly enhance the Fleet's capability to fight fire while under chemical attack.

Utilization and Impact

As a result of these developments, the Naval Sea Systems Command (NAVSEASYSCOM) is planning to incorporate smoke and toxic gas control capabilities with collective protection systems to be installed on future ships. In a near term new construction class, the CPS on the DDG 51 will not incorporate this capability, but SEA 55X is determining whether any capability for smoke control is available with the CPS on DDG 51; DTNAVSHIPRANDCEN is supporting SEA 55X in this effort.

Research and Development Notes

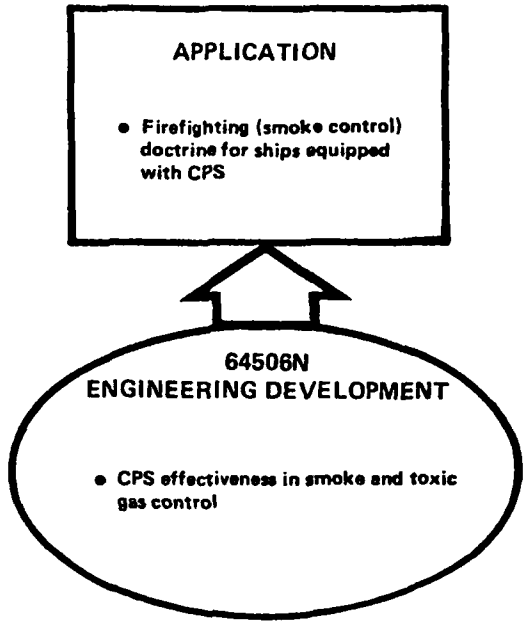
This research was performed at DTNAVSHIPRANDCEN under the sponsorship of NAVSEASYSCOM. The project was funded under Program Element 64506N, Chemical Warfare Countermeasures, Project SO410-SL; Task CP8S, "CPS Damage Control: Smoke and Toxic Gas Control Using CPS." The program manager was C. Pohler (SEA 05R23); the technical agent was LCDR D. Klinkhammer, USN (SEA 55XC). The project was initiated in FY82 and will be completed in FY88.

Additional information may be obtained from MATRIS using the following indexing vocabulary:

- Primary Terms:
  - 10.01.17 Fire Control Systems
  - 10.07.39 Chemical Warfare Factors
  - 10.07.29 Emissions/Smoke/Vapors
  - 10.01.03 Surface Ship Systems

- Secondary Terms:
  - 10.07.30 Breathing Gases (Narcosis, Transfer, Exchange)
  - 10.07.26 Radiation
  - 10.08.26 Mockups (3-dimensional)

Program dynamics are:



SHIP DISTANCE MONITORING SYSTEM FOR UNDERWAY REPLENISHMENT OPERATIONS

Need

Replenishment of ships while underway (UNREP) is a dangerous maneuver. Reported repair costs from accidents during UNREP exceed $140K per year. More importantly, many ships suffer unscheduled downtime while being repaired. One of the critical requirements of UNREP operations is to maintain station at the proper distance from the replenishment ship. The present method of measuring the separation distance is to count multicolored flags on a distance line strung between the two ships. Development of an improved sensor and display system, using a remote distance sensor, will improve ship control during replenishment operations and reduce accidents.

Approach and Results

Previous Exploratory Development demonstrated ship controllability during UNREP on a computer simulation model; identified and described parameters that must be sensed for proper ship control during UNREP; developed an improved quickened display for the helmsman; and identified remote sensors available from private industry which can be used to sense separation distance and closure rates.

In the next phase, appropriate sensors and displays will be procured and evaluated for usefulness in ships' bridge wing areas under night and day conditions for visibility and meaningfulness to ships' personnel. A simple, reliable and meaningful monitoring and display system is the goal of this effort.

To ensure the success of this effort, a hybrid computer facility has been used to simulate the ship and sea state model operating with models of the ship separation sensor, bridge wing display and controller. Bridge wing display layout and technology have been selected. New sea state data have been added to the computer simulation model to include operation scenarios with quartering seas. A report is in preparation documenting the simulation effort, evaluating the effect of sensor location, and quantifying the effects of ship movement (i.e., roll, pitch, yaw, heave, surge, and sway).

An experimental model of the monitoring system will be installed and evaluated aboard a ship in FY85. Specifications for procurement will then be completed and a system procured, technically evaluated, and installed aboard ship for final evaluation in the FY86 to FY88 time frame.

Utilization and Impact

Specifications developed during this work will be used to procure ship distance monitoring systems for use on combatants and on replenishment ships.

The ship distance monitoring system will:

- Provide meaningful and timely information to ship operators.
- Improve capability to replenish underway during marginal conditions such as low visibility and high sea states.
- Improve safety during UNREP.
- Reduce the number of accidents and therefore reduce direct repair costs.
- Minimize unscheduled downtime for ships.

Research and Development Notes

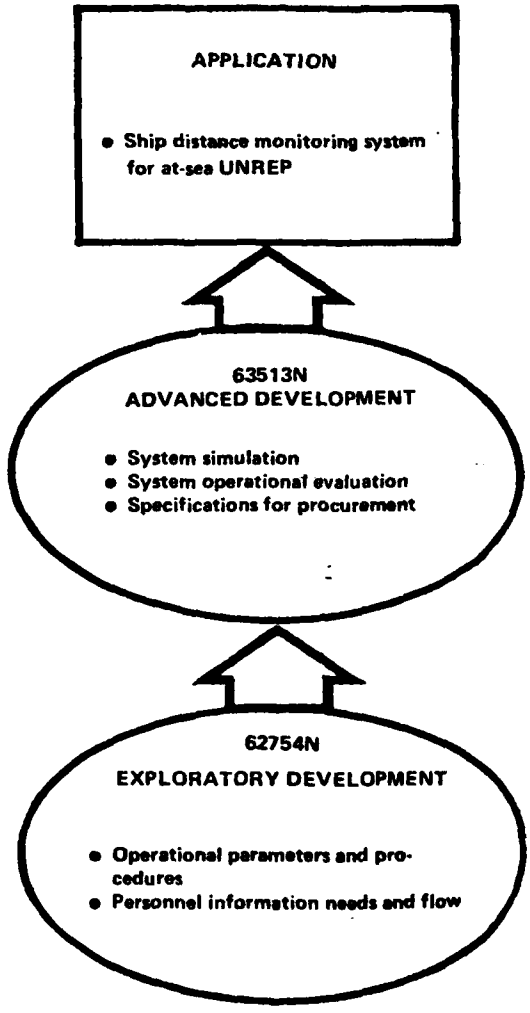
This work is funded in Program Element 63513N, Shipboard System Component Development, in Project SO382-8L. It is sponsored by the Naval Sea Systems Command (NAVSEASYSCOM). Work is being conducted by the David Taylor Naval Ship Research and Development Center (DTNAVSHIPRANDCEN), Annapolis, Maryland, 21402. The responsible researcher is R. Wayle (Code 2732), (301) 267-2163, Autovon 281-2163. Many reports and papers have been issued to date; the more recent ones are:

- "Simulation Analysis of Steering Control During Underway Replenishment," Brown, Samuel H., and Dimmick, Joseph G., *Journal of Ship Research*, Vl. 27, No. 4, December 1983.
- "Sensing Systems for Measurement and Control of Relative Ship Position Over Close Ranges (Underway Replenishment)," Henry K. Whitesel and Ralph E. Wayle, Sixth Ship Control Systems Symposium, 26-30 October 1981.
- "Automatic Control of Lateral Separation During Underway Replenishment," John R. Ware, John F. Best, ORI, and Henry K. Whitesel, DTNAVSHIPRANDCEN, Sixth Ship Control Systems Symposium, 26-30 October 1981.
- *Control System Design for Close Range Ship Control System*, Volumes I and II, John R. Ware and John F. Best, ORI, December 1981.

Additional information may be obtained from MATRIS using the following indexing vocabulary:

- Primary Terms:
  - 10.01.03 Surface Ship Systems
  - 10.01.52 Sensor Systems (BETA)
  - 10.08.24 Display Organization and Layout (Visual)
  - 10.15.20 Replenishment (Stores, Weapons)
- Secondary Terms:
  - 10.05.01 Control-Display Dynamics (RPV)
  - 10.02.26 Displays, Navigation Data
  - 3.02.57 Shiphandling/Piloting Training
  - 9.02.12 Simulation (Dynamic Flight, Ship Motion)
  - 10.07.35 Night Operations
  - 9.02.22 Monitoring Systems, Performance/Physiological
  - 9.03.08 Perception, Motion
  - 9.03.15 Perception, Depth
  - 10.08.10 System Safety Design

Program dynamics are:



SIMULATION AND TRAINING DEVICES

In the Department of Defense, this area of People-Related RDT&E involves the "Development of cost effective training equipment and technology that produce the needed performance for operation and maintenance of military systems."

The Navy needs training devices and simulators for several purposes: to improve readiness through realistic exercise; to reduce training costs; to increase safety during practice of dangerous activities; and to reduce the destructive impact of training activities on the environment.

Projects in this category include:

- **Anti-Submarine Warfare (ASW) Training Simulation Research Facility**
- **Stand-Alone Maintenance Aids (SAMAs)**

ANTI-SUBMARINE WARFARE (ASW) TRAINING SIMULATION RESEARCH FACILITY

In this issue of the report, there are two articles which deal with simulation facilities related to acoustic signals in the ASW context. One article, in the Section on Training Devices, discusses an ASW Training Research Facility. The other, in the Section on Human Factors Engineering, discusses a Real-Time Simulation for Testing ASW Signal Processing Systems. While there is clear commonality of subject, and coordination between the projects, the differing objectives should be kept in mind because they impact upon and cause differences in the characteristics of work undertaken.

Need

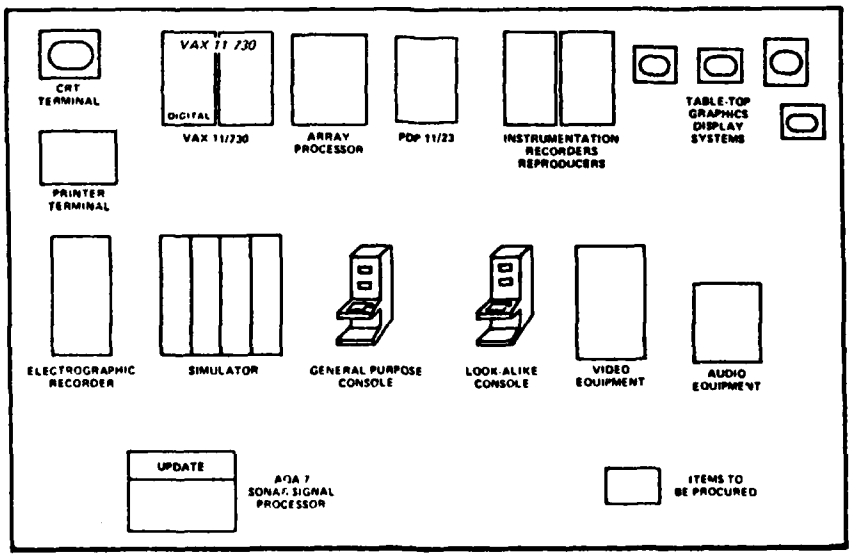
The complex skills required for ASW operation dictate a need for a continuous pipeline for training new operators and a means of providing refresher training for experienced operators. In particular, acoustic proficiency tests have confirmed the extremely perishable nature of acoustic operator skill levels. To provide training, current technology uses operational equipment with expensive stimulators. Cost constraints limit the amount of formal training that can be provided.

At present, training of acoustic analysts utilizes static paper copies of lofargrams, while modern acoustic processing systems employ CRT displays. Preliminary information on the difficulty students have in adjusting between the linear paper lofargrams provided by the AN/AQA-7 and the CRT logarithmic displays provided by the OL-82 or AN/UYS-1 indicates the need for a training device to display dynamic lofargrams and allow the student to make measurements using electronic cursors. Paper copies of lofargrams in a logarithmic format cannot be used to provide training in determining harmonic relationships. A current Operational Requirement states the need for a portable lofargram analysis and refresher trainer for the OL-82 signal processor installed in the S-3A aircraft. A similar need has been expressed by users of other sonar systems in the air, surface and subsurface communities. The military characteristics of lofargram analysis trainers for the P-3C (Update III) and subsurface systems (AN/BQQ-3, AN/BQQ-5, AN/BQQ-6, and AN/BQR-22/23) have been developed and are being reviewed by their respective Fleet project teams.

There are other needs in addition to the requirement for improved training for passive acoustic system operators. Among these are reduction in the cost of trainers, which typically use operational equipment with stimulators to create the proper acoustic environment; reduction in the cost of ocean models; and quality control of target models.

Approach and Results

Development of the ASW Simulation Research Facility requires the procurement of a computer system and display devices suitable for simulation of ASW displays. Due to the security classification of the data used in ocean and target modeling, the ASW displays being developed cannot be generated on a time-shared system accessible to many users. Therefore, a separate facility is required. The accompanying figure shows the equipment requirements for the facility.



ASW SIMULATION RESEARCH FACILITY

The research to support the development of the simulation facility is focused in seven areas: low-cost methods of lofargram generation; mathematical modeling of targets and ocean environment; stimulator techniques; console development; instructional system development; target data base development and validation; and ocean model implementation. The project combines work initiated under two earlier projects, Development of Computer Models for Multiple ASW Trainer Applications, and Simulation Techniques for Basic ASW Operator Training.

ASW training requires the simulation of realistic sonar displays. Lofargram displays, in particular, are difficult to simulate with sufficient realism for training of experienced acoustic operators. A low-cost method for generation of realistic lofargrams for tabletop passive acoustic analysis (PAA) trainers has been developed. The feasibility model has been demonstrated to the Anti-Submarine Warfare System Project Office (PM-4) and to the Passive Acoustic Analysis Working Group in San Diego. Further work is being performed to develop harmonic dividers, reference mark capability, and non-linear presentation display capability for the demonstration unit. An aural capability will be added by the development of a low-cost digital storage technique to store the audio signals and the digital information for generating a simulated ASW display on a videodisc.

Currently ASW operator and tactics trainers use operational equipment stimulated by synthetic acoustic signals. This approach is very expensive because of the high cost of the operational equipment. Improved methods for mathematical modeling of sonar signal processing and the target and ocean characteristics will provide direct simulation of ASW displays without the need for operational equipment. Look-alike consoles will be developed to provide training in use of operational equipment without the cost of the actual equipment. The combination of mathematical models and look-alike consoles will provide the free-play needed for team tactics training and support an instructional system to measure student performance. An instructional system that allows self-paced, computer-aided instruction will be designed and evaluated.

Acoustic target generators are used in many training devices and the projected growth of embedded and organic training will require further application of stimulators. Improved mathematical models will be developed to support the higher fidelity of simulation required for the more sophisticated sonar systems being introduced into the Fleet.

The Naval Training Equipment Center (NAVTRAEQUIPCEN), in conjunction with other Navy laboratories, has developed a data base of target models for training and applications. The simulation facility will be used to extend the data base and to devise a validation procedure to ensure that targets added to the data base meet some standard of acceptability.

Simulation of the effects of the ocean environment upon the propagation of acoustic signals is a critical part of ASW trainers. As part of this project, NAVTRAEQUIPCEN is developing a Standard Ocean Model. This model will be furnished to contractors as government furnished information, thus eliminating contractor development of a new ocean model for each system.

Utilization and Impact

This effort supports acquisition of new ASW training systems and modernization and updating of current ASW training systems. Representative training systems include Device 14A12, Surface ASW Trainer; Device 20A66, Tactical Team Trainer; AN/BQQ-5C, Sonar Operator Trainer; AN/BQQ-5C, Team Tactics Trainer; AN/BQR-20/22, Sonar Operator Training; AN/SQQ-89 suite (AN/SQS-53B, AN/SQQ-28 LAMPS MK III, AN/SQR-19); and AN/SQS-53C. The simulator development also has significant potential to facilitate evaluation of operational systems at the Battle Group Level Support Facility planned for Wallops Island in the late 1980s.

Although this project is supporting ongoing acquistion programs by providing an ASW technical base for training, its main objective is to explore new ground in ASW simulation technology for training. This combination of equipment provides the tools necessary to investigate and evaluate methods of simulation for ASW training. The training effectiveness of various simulation techniques will be evaluated prior to building a trainer. The ocean model and the sonar and target data bases developed will be usable by all future ASW trainers. Data derived from the evaluation of the trainers will be translated into engineering specifications for ASW trainer procurements, resulting in training systems which use state-of-the-art equipment and training methodology. The payoff will be increased operator efficiency at the operational site and a substantial reduction in acquisition and life-cycle cost of trainers.

This project also provides a test bed for ASW systems research and evaluation. It provides data for an Advanced (6.3) Development effort that will apply the techniques developed to provide demonstration models of low-cost tabletop trainers for PAA, multistation team tactics trainers, and stimulators for onboard trainers. The low-cost tabletop trainer models will be used for evaulaiton of simulation methods and training effectiveness. The stimulator capability will also be used for validation of target data bases and for preparation of training tapes for Device 14D1, Aviation Anti-Submarine Warfare Basic Operator Trainer.

The results of this research will be used by NAVTRAEQUIPCEN for development of demonstration models and for pilot tests of training effectiveness. The results will also be used in the development of specifications for new trainers and for the evaluation of contractor proposals. The potential savings that will result are:

- 10 to 1 savings in hardware cost by replacing government furnished equipment (GFE) with commercial equipment.

- $400,000 savings per trainer by using a standard ocean model.
- $300,000 savings per trainer by using a standard target data base.
- $100,000 savings per trainer by using a standard sonar simulation data base.

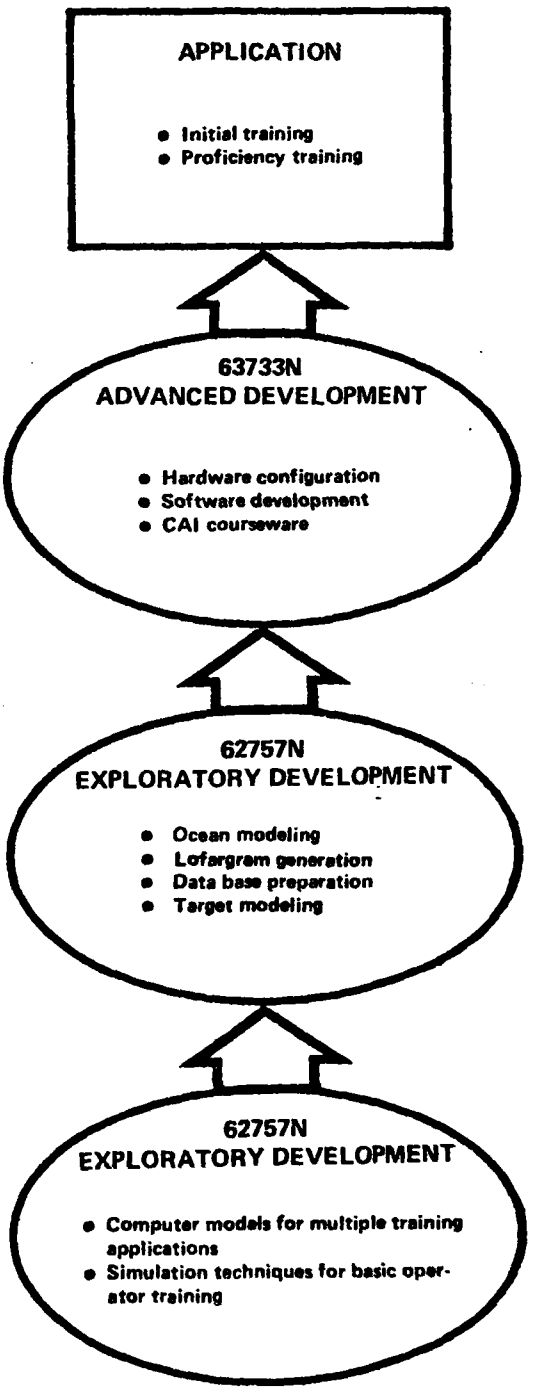
Much of this development will also apply to other warfare areas. For example, the console, graphics displays, and auxiliary devices used to generate sonar displays are very similar to those needed for simulating EW displays.

Research and Development Notes

This project is being performed under the cognizance of the Naval Training Equipment Center, Orlando, Florida, 32813. The responsible researcher is Dr. L. D. Healy, (Code N-74), (305) 646-4491/5415. Contractor support is provided by TRACOR, Inc., 6500 Tracor Lane, Austin, Texas, 78721, and Sanders and Associates, P.O. Box 868, Nashua, New Hampshire, 03011. The work was initiated in FY82 and will be completed in FY88. Funding is currently provided in Exploratory (6.2) Development Program Element 62757N, Human Factors and Simulation Technology, Project WF57-526, Anti-Submarine Warfare (ASW) Simulation Research Facility. A paper, "Standard Ocean Model for ASW Training," by L. D. Healy and others, was presented at the Summer Computer Simulation Conference, Boston, Massachusetts, July 1984. Additional information can be obtained from MATRIS using the following indexing vocabulary:

- Primary Terms:
  - 3.07.08 ASW Simulation (Adaptive Maneuvering Logic)
  - 3.08.27 Anti-Submarine Warfare (ASW) Trainers (Tactical)
  - 3.08.20 Sonar Target Simulation Vehicle
  - 3.08.15 Sonar Acoustic Warfare Training Systems, Generalized
- Secondary Terms:
  - 4.03.22 Training Research Facilities/Equipment
  - 3.09.22 Target Simulation Devices (Surface, Submarine)
  - 10.01.19 Acoustic Warfare Systems
  - 10.02.02 Displays, Interactive (Sonar)
  - 4.02.06 Sonar Acoustic Warfare Parameters Models
  - 10.08.32 Mathematical Modeling
  - 3.04.12 Computer-Aided/Assisted Instruction (CAI)
  - 4.03.03 Simulation Fidelity (High/Low Image Generation, Cost)
  - 3.02.43 Refresher Training
  - 9.04.01 Auditory Signal Classification (Acoustic Transients)

Program dynamics are:



STAND-ALONE MAINTENANCE AIDS (SAMAs)

Need

It has been recognized for some time that the complexity of modern weapon systems challenges the capabilities of military technicians. Training technicians to maintain these sophisticated systems is both difficult and costly. In particular, troubleshooting is the most difficult cognitive skill to be acquired by maintenance personnel: Present methods of troubleshooting training do not produce the skills which enable technicians to diagnose and correct problems effectively.

In 1981, Congress directed the Department of Defense (DoD) to conduct increased joint service developmental and demonstration projects in training and training technology in areas where mutual benefit could be realized by the participating services. In 1982, a joint Army and Navy Engineering (6.4) Development effort began to develop microcomputer-based aids for maintenance training and job aiding. The project was designated "Personal Electronic Aids for Maintenance (PEAM)." The purpose was to design, develop and test a PEAM system for maintenance training and job aiding applications with potential implementation in all DoD activities in which complex maintenance skills are taught or required.

To produce this system, Exploratory (6.2) and Advanced (6.3) Development efforts were required to generate design concepts and functional specifications. Additionally, research tools were required for experimental purposes and for demonstrations. These research tools were designated as "Stand-Alone Maintenance Aids (SAMA)."

Approach and Results

Exploratory Development efforts to facilitate maintenance troubleshooting training focused on the development of SAMA 1, a special purpose, hand-held computer to be used by technicians to aid in troubleshooting. The design of this system was patterned after the Logic Model (LOGMOD) Device which was produced in 1976 and has subsequently been demonstrated and employed in military and commercial applications. The SAMA 1 was envisioned as a miniaturized version of the LOGMOD capable of producing proceduralized instructions for maintaining high complex weapon systems. Dependency, test and repair data were provided as inputs, using the LOGMOD source program. These inputs were processed, analyzed and translated into desired output data in a format suitable for use in field maintenance. The two components of SAMA 1 developed in this 6.2 effort were the diagnostic aid with alphanumeric display capability for use as a portable, battery-powered aid, and the SAMA "Mother Unit," a tabletop device which functions similarly to the SAMA and serves as a mass memory repository.

For use in field maintenance the desired data base is downloaded from the "Mother Unit" into the portable SAMA 1. If any system event is observed to be out-of-specification, the related component(s) can be accessed in the data base. Once accessed, all of the contributing components upon which the failed event depend are available. The object program counts all of the contributing components, divides the number by two, selects a "half point" event to be tested, examines that event for accessibility, and, if suitable, displays the test data for that event on a computer-controlled display. The technician makes the indicated test and enters GOOD or BAD based on evaluation of the observed indication. The object program then performs the split-half division process again and displays the new test data. After a sufficient number of tests have been completed (some good, some bad), the number of contributing dependencies will be reduced to the point at which only one component (or a small fault group of component) can be responsible for the specific out-of-specification events. When this isolation occurs, the SAMA displays the repair data associated with that component, and the technician is directed to (or referred to existing technical manuals) to replace, adjust, or repair the faulty component, and retest the original faulty event to confirm that the fault has been corrected.

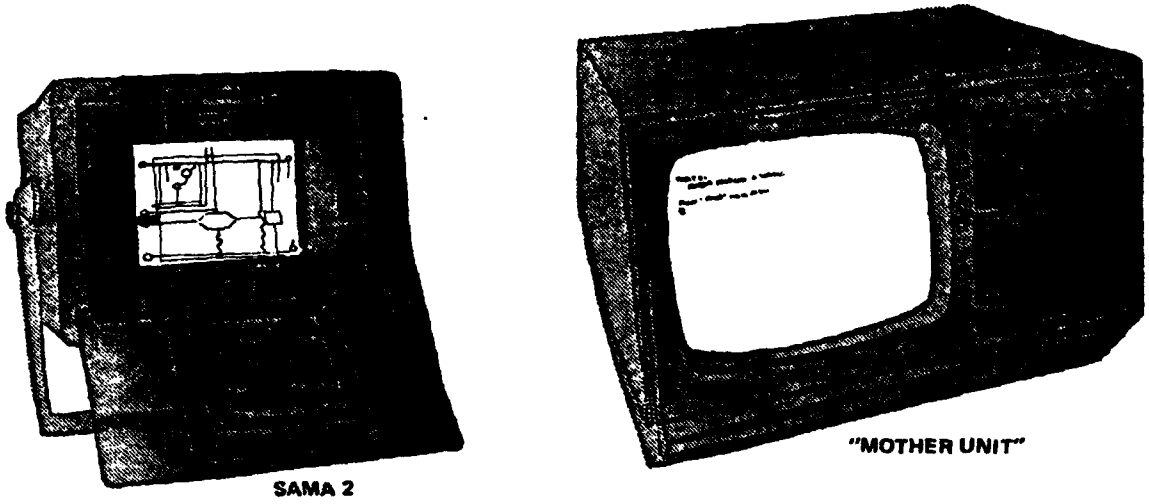
Following successful development of SAMA 1 and its associated "Mother Unit," design concepts were formulated for the more complicated counterpart to SAMA which would be developed in the ongoing Engineering (6.4) Development PEAM system. The project then transitioned to Advanced (6.3) Development for further refinement and experimental applications. Data bases were compiled and experimental demonstrations were successfully conducted. The results substantiated that troubleshooting tasks could be accomplished more efficiently using the SAMA 1 system rather than conventional paper job aids and technical manuals.

During this same period, SAMA 2 was developed. The accompanying figure depicts both SAMA 2 and the "Mother Unit." SAMA 2 employed the basic functions of SAMA 1 but also provided improved display characteristics by adding graphics.

Utilization and Impact

The SAMA 1 device underwent field evaluations at two P-3C squadrons and the MK 86 Gun Fire Control School with successful results. In addition, the Air Force has adapted the SAMA 1 concept for use as a Battle Damage Assessment tool. Although the SAMA could be implemented as a troubleshooting tool, its purpose for this research is to validate concepts for the larger DoD PEAM program. Current and planned research and development using SAMA 2 will address the use of this device as a troubleshooting training tool. Experimental training software is under development. Experiments in the Navy Basic Electricity and Electronics (BE&E) School will begin in early FY85.

By developing troubleshooting techniques and using the SAMAs 1 and 2 as research tools for experimental applications, a great deal of risk has been eliminated from the PEAM project. PEAM development has all-service applicability.



SAMA 2 AND "MOTHER UNIT"

There are two major components: the Maintenance Information Delivery System (MIDS), and the Maintenance Information Authoring System (MIAS). MIDS is a portable, microcomputer-based device which presents training and aiding information through graphic displays and synthetic speech. MIAS consists principally of software, executable on a standard commercial computer, which is used to facilitate the production and configuration control of weapon system-specific data bases for the MIDs. The SAMA and its "Mother Unit" correspond respectively to the MIDS and MIAS of this PEAM project. The initial test and evaluation of the PEAM system are scheduled for the Army M-1 tank community.

Innovative high visibility demosntrations of microcomputer technology for maintenance training and aiding applications will enhance the designation of potential applications. Other potential benefits include:

- Reduction of initial qualification standards for maintenance technicians.
- Reduction of technician training time and training costs, and an increase in diagnostic and fault finding capabilities.
- Reduction of time required to repair weapon system components with portable troubleshooting aids readily at hand. Readiness could be significantly increased as a result.
- Easy and rapid incorporation of changes in maintenance instructions through digital communications.

PEAM concepts are intended to have broad applicability for use by technicians on any military weapon system having complex maintenance requirements. SAMA applications will enhance the success of the PEAM Project.

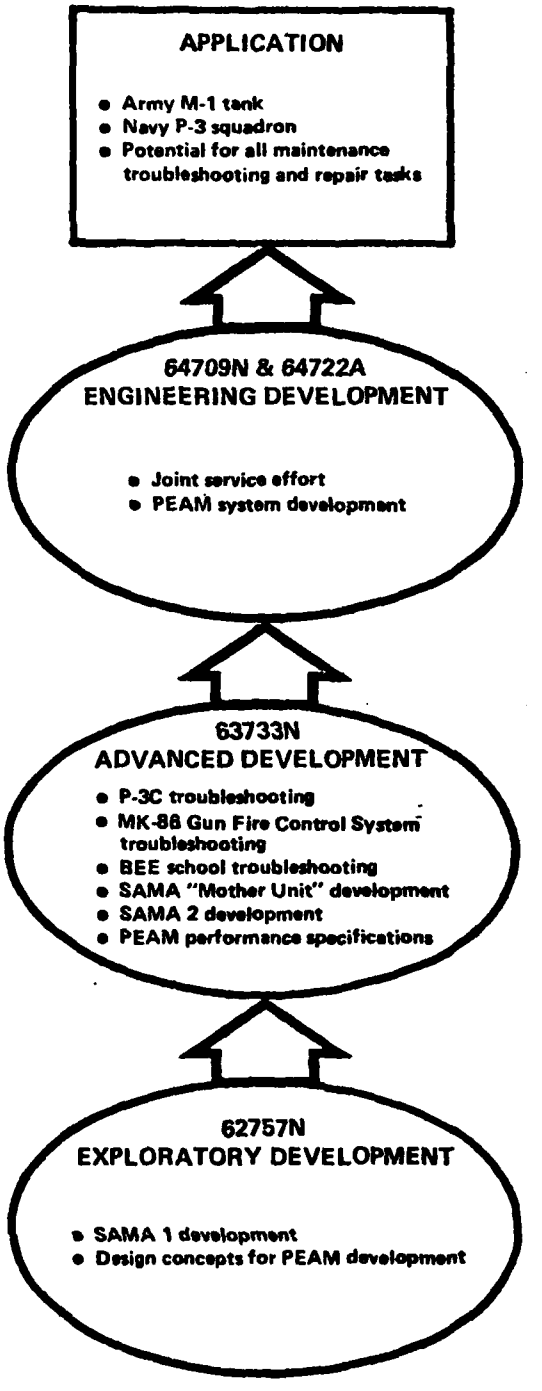
Research and Development Notes

This development was initiated in October 1981 and will be completed in September 1985. The effort is being managed by the Human Factors Laboratory of the Naval Training Equipment Center (NAVTRAEQUIPCEN), Orlando, Florida, 32813. Contributing agencies include the Office of Naval Research (ONR), the Navy Personnel Research and Development Center (NAVPERSRANDCEN) and the Project Manager for Training Devices (PM-TRADE), U.S. Army. The responsible researcher is Mr. W. A. Rizzo, NAVTRAEQUIPCEN (Code N-712), (305) 646-5130. The principal investigator is Dr. Ralph DePaul, Detex Systems Corporation, Villa Park, California, 92667. Exploratory Development was funded in Program Element 62757N, Human Factors and Simulation Technology, and Advanced Development in Program Element 63733N, Training Device Technology. The work is currently identified as Project D750, Education and Training Systems, in Program Element 64722A, Education and Training Systems. No reports have been published,

but information can be obtained from MATRIS using the following indexing vocabulary:

- Primary Terms:
  - 3.10.07 Automated Maintenance Training (Troubleshooting)
  - 10.10.01 Job Performance Aids Development
  - 3.10.12 Computer-Assisted Feedback Systems
  - 10.01.36 Weapon Systems
- Secondary Terms:
  - 10.14.11 Job Performance Aides T&E
  - 10.10.02 Maintenance/Troubleshooting Aids (Logic Trees)
  - 3.10.08 Computer-Based Training Aids, Generalized
  - 3.15.04 Training Device Effectiveness
  - 11.02.04 Computerization Techniques
  - 10.10.10 Technical Data, Textual/Graphic
  - 3.02.02 Remote Site
  - 12.05.04 Joint Service Development/Utilization

Program dynamics are:



CUMULATIVE INDEX TO PREVIOUS ANNUAL REPORTS

There have been six previous annual reports. This index will assist in identifying articles of interest in those six and this seventh. The index is arranged in the order of the second level terms in the Human Resources Research Indexing Vocabulary of the Manpower and Training Research Information System (MATRIS). The nature of the indexing vocabulary is such that many of the articles could be indexed under several terms. However, for purposes of simplification in this index, the "best or most likely" term has been selected.

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